URBAN AND COMMUNITY FORESTRY

A Guide for the
Interior Western United States

United States
Department of
Agriculture

Forest
Service

**Intermountain
Region**

Ogden, Utah

URBAN & COMMUNITY FORESTRY
a Guide for the
Interior Western United States

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DEDICATION

This guide is dedicated to citizens interested in trees and to community leaders responsible for care of trees. May its use establish many effective tree care programs.

Michael L. Hanson
Urban Forestry Coordinator
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PREFACE

Hundreds of cities, towns, and unincorporated areas in the Interior Western states have a valuable but often overlooked forest resource: Trees! Trees that grow along streets, in parks, cemeteries, school grounds, and on other public and privately-owned lands constitute urban and community forests.

Pioneer settlers and succeeding generations planted most of our western community forests. Unfortunately, many forests with promising pioneer beginnings have fallen into neglect. Old age, disease, and thoughtless tree removal have taken their toll. Plantings in older neighborhoods are dying out. Few new trees are being planted to replace the losses. In fact, many communities remove more trees from public lands each year than they plant. Many new subdivisions and parks as well as commercial and industrial areas remain barren and treeless. Where tree planting has accompanied new development, it is seldom planned and often inconsistent with existing tree plantings and community patterns. We have forgotten that most of the urban and community forests on the steppes, deserts, and prairies, of the interior west were planted, not found, and that these forests, like natural forests, must be renewed if we are to continue to enjoy the benefits they provide.

The first edition of this manual addressed the pressing need for community forest renewal and care. It was written as an introduction to the art and science of urban and community forestry, presenting the best "how to" information available to a specific audience in Utah and Southern Idaho. All aspects of community forestry were discussed–everything from initiating a program to long-range maintenance planning.

To assist in determining what types of revisions should be made in the second edition, a questionnaire was mailed to 265 urban forestry professionals in 16 western states and to 75 nationally recognized leaders in urban forestry. This will be referred to in future chapters as the "urban forestry questionnaire". Respondents who had experience with the first edition of the manual were asked to critique it; others were asked to comment on a proposed outline for the second edition. Their responses and suggestions are incorporated throughout this edition.

This updated edition also responds to changes in the field of community forestry over the past seven years and incorporates new information in such areas such as urban soils, xeriscapes, tree inventories, tree care programming, urban wildlife, liability, and litigation. The geographic focus of the second edition has been expanded to meet the urban and community forestry needs of 18 states: Arizona, Colorado, Idaho, Iowa (northwestern), Kansas, Minnesota (western), Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon (eastern), South Dakota, Texas (western), Utah, Washington (eastern), and Wyoming.

This manual provides general information of value to interested citizens and community leaders as well as specific technical data useful to professional foresters, arborists, horticulturists, landscape architects, and others involved in community forestry programs.

Although the manual focuses on the Interior Western region, the concepts and ideas covered in it apply to other regions of the country as well. It is designed to meet four objectives:

1. Seek out and support persons currently interested in and responsible for municipal or community tree care.
2. Revitalize public interest in and support for urban and community forestry programs.
3. Explain a process for transforming community interest into action.
4. Provide the technical information about tree selection, planting, and maintenance procedures necessary to improve existing forests or establish new ones and perpetuate the community forest.

Information of necessity is general and hence does not address unique problems that may arise in any particular city or town. The manual does, however, list agencies and organization which can provide sources of technical assistance with personnel capable of responding to special problems.

The preparation of this manual required the combined efforts of the authors and a number of dedicated people. In addition to the original authors, advisory board members, and reviewers, a number of professionals have made their contributions. Mike Hanson, U. S. Forest Service, State and Private Forestry Coordinator for the Intermountain Region, proponent of a revised and updated second edition, deserves special recognition as does the Project Leader, Gordon Younker, Chief Forester for AAA Engineering and

Drafting, Inc. Special contributions have been made by Richard Fisher, Phil Hoefer, Wayne Johnson, and Gary Merrill, and graduate assistants Susan Nordstrom and Stefan Zeglen. We are in debt to the authors and sponsors of the first edition as well, in particular Greg McPherson, Scott Gutting, and David Schen. The graphics of Dave Socwell and Kathlyn Collins, and the photographs of Art Whitehead enhance the quality of this edition. Critical reviews of this edition by Gary Merrill, Steve Schwab, Dick Hildreth, Jim Nighswonger, Phil Hoefer, Jack Scherting, Mike Hanson, and Gordon Younker have improved its quality. Without the contributions of all these professionals, this second edition could never have become a reality.

Craig W. Johnson
Fred A. Baker
Wayne S Johnson

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I. INTRODUCTION

INTRODUCTION

Definitions

Few communities in the Interior Western region as shown in Figure 1-1 exceed a population of 30,000; most are in rural settings. Community forestry rather than the more common term, urban forestry, would best describe the scale and character of tree planting and maintenance activities in this region.

Figure 1-1. The Geographic Region for Which the Manual is Designed (1) Steppes, Deserts, Prairies, and (2) Mountains

What precisely is community forestry? For the purposes of this manual, we have adopted the following definition: "The planning, design and management of vegetation on public lands in and around communities to maximize their visual, social, economic and environmental contributions to the well being of the community" (Gallaher, 1981).

Who practices community forestry? Practitioners are interested citizens and community leaders. Interested citizens are persons in the community with the energy and desire to plant and care for trees. Leaders are persons responsible for or trained in tree care.

Those <u>Responsible May Be</u>:	Others <u>Trained May Be</u>:
Mayors	Horticulturists
Council Members	Nursery Personnel
City Managers	Plant Scientists
City Arborists	Planners
City Foresters	Tree Workers
City Landscape Architects	Conservationist
City Engineers	Botanists
Forestry Foremen	Ecologists
Tree Wardens	
Parks and Recreation Directors	
Public Works Directors	
Other Positions	

Kielbaso (1988) uses the title, Tree Care Manager, to encompass all titles and skills. Throughout this manual the phrase "the persons responsible for tree care" is used to describe those involved in tree care activities, and the terms "urban or city forester" refers to a trained professional forester.

Program Development

Only an estimated seven percent of United States cities and towns have effective community forestry tree care programs. (Hanson, *et al.* 1987) This is true for the approximate 7000 cities and towns in the Western United States. Much must be done to rejuvenate existing programs and develop new ones that are effective. Effectiveness indicators were suggested in a recent community forestry assessment, (Hanson, *et al.* 1987). Indicators include:

1. Tree care agency or at least a person or persons responsible for tree care designated by ordinance or by community leadership.

2. City line item or identified budget generated from several sources (for example: general funds, development assessments, donations, fund raisers, payments-in-kind, etc.)

3. A well-managed and maintained publicly owned tree resource.

4. Trained tree workers and arborists in public and private tree care.

5. Workable tree ordinance or tree regulations and guidelines.

6. Annual work plans for public tree care.

7. Developing or working under a master plan that involves all major elements of a city's infrastructure.

I. INTRODUCTION

Definitions
Program Development
Foundation Building
Data Collection
Analysis and Evaluation
Implementation

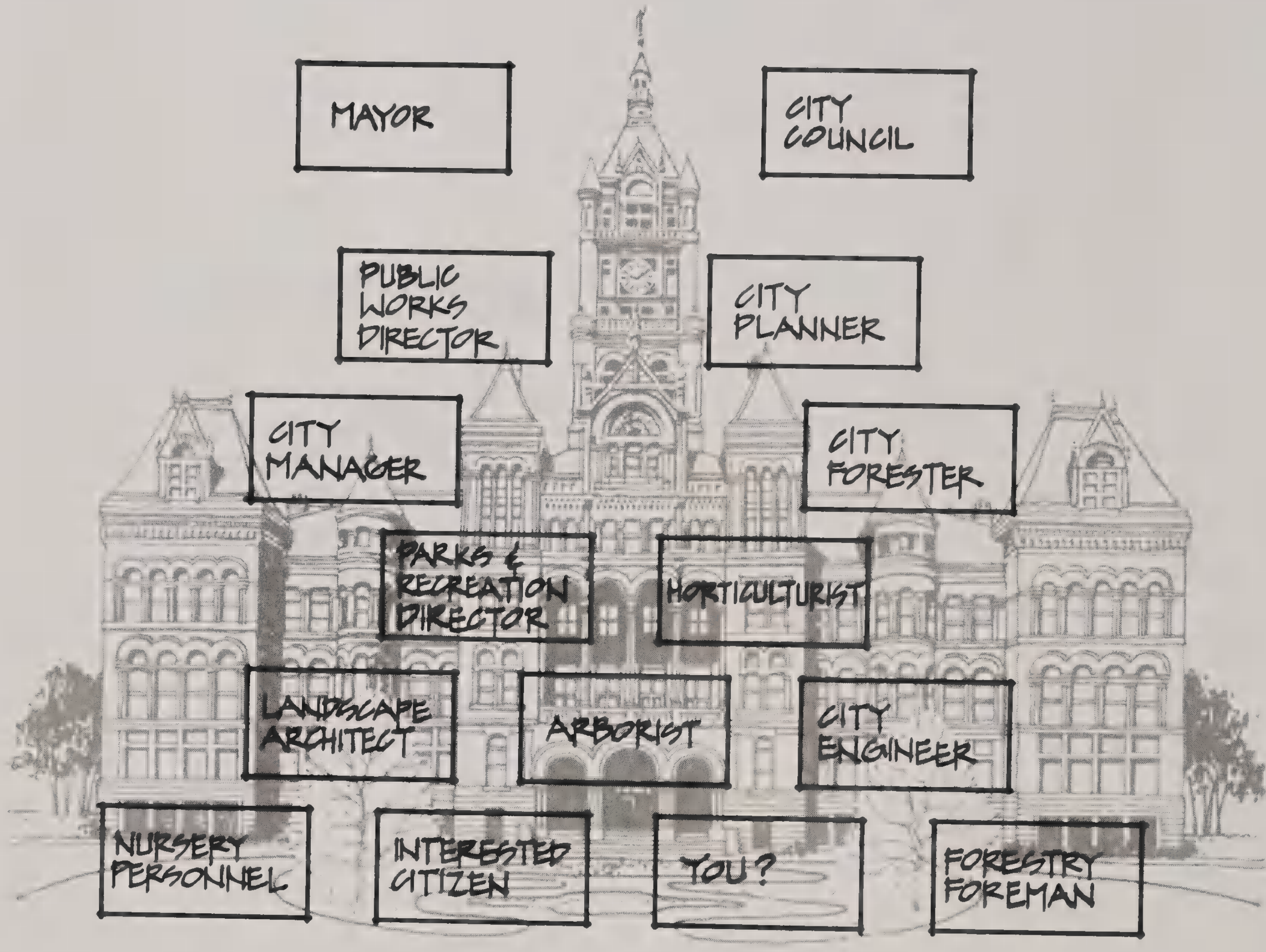

Figure 1-2. Person(s) responsible for tree care

8. Initial and continuing participation in new developments and growth areas.

9. Inventories or assessments of the tree resource.

10. Education and outreach to citizens, school children, teachers, and political and city leaders.

11. Citizen and leader participation in planning and implementing tree care programs (including Arbor Day proclamation and Tree Planting ceremonies, awards, and other recognition and project functions).

12. Media involvement and coverage of forest conditions, tree care activity, and citizen involvement and recognition.

Community forestry begins at a grass roots level; interested local citizens are the driving force. A logical process is needed to coordinate citizen participation and integrate forestry program elements. Citizen and community leader involvement, and at times technical assistance from government agencies, universities, and private consultants are required to keep the process going. This group melds into a working team that will develop and maintain the community forestry program. Excellent examples of successful forestry programs in the Interior Western states can be found in Lawrence, Kansas; Brookings, South Dakota; Boise, Idaho; Murray, Utah; Colorado Springs, Colorado; and other communities both large and small. A recent small town example is Wellsville, Utah (population 2,000). Program development in Wellsville demonstrates that establishing and maintaining a community forest program is not beyond the means of even the smallest communities. What is required is awareness, interest, enthusiasm, and commitment.

If community forestry is a grass roots activity, how do citizens and leaders start a program? And, once started, how do they continue to support it? Herein lies the reason for this manual. The manual presents a logical, step-by-step process to start and to continue a community forestry program. The process includes four phases:

Foundation Buliding

1. Identify and support persons responsible and interested in municipal tree care.
2. Establish a shade tree commission or tree board.
3. Enlist and involve media representatives.
4. Assess resident interest.
5. Set short and long range goals.

Data Collection

1. Map community patterns in terms of landscape character, land-use and street features.
2. Assess current policy, personnel, and equipment in public tree care.
3. Inventory tree species, tree spaces, sizes, conditions, locations, and needs.
4. Assess administrative support.

Analysis and Evaluations

1. Analyze community pattern maps, current program assessment, and tree inventories.
2. Establish long and short term goals.
3. Develop the community forest plan map and report.

Implementation

1. Analyze visual, biological and functional project site conditions that influence tree selection.
2. Select and properly plant trees suited to site conditions.
3. Develop an annual maintenance schedule and annual work plans.
4. Maintain and improve the community forest using recommended practices, including education and outreach to private citizens.
5. Provide awards and recognition on a continuing basis.
6. Update the forest plan periodically.

The degree to which these phases are organized and the level of sophistication with which they are executed will vary with each community. The following is a summary of each program phase as diagrammed in Figure 1-3 and explained in detail in the following chapters. The case study chapter provides a written narrative of this process, highlighting the activities as applied in the hypothetical community of Grove City, Nebraska.

Foundation Building

Community forestry program development or improvement begins with identification of persons responsible or interested in municipal tree care. Mayors or city managers have executive program responsibility, and city or town councils have legislative or enabling responsibility. Executive authority empowers individuals, public works agencies, or contractors to provide tree care. Thus, it is essential to identify, support, and work with persons in these organizations in foundation building activities (Miller, 1988 and Kielbaso, 1988). Greg Ruether, City Forester, Overland Park, Kansas, says **"A lot of success in tree management can be attributed to cooperation of the city council and other city leaders responding to requests by citizens."**

A community forestry program can progress with the establishment of some form of organization either within or advisory to city government, such as a Shade Tree Commission or Community Forestry Board. This organization is then authorized to make decisions regarding the community forest. The support and assistance these advisory groups receive from garden clubs, beautification groups, tree enthusiasts, environmentalists and others is critical in program development. Several communities within the region including Omaha, Nebraska and Overland Park, Kansas have working Shade Tree Commissions. For most smaller communities, establishing such an advisory commission will be the first step taken toward a forestry program.

Traditionally, Shade Tree Commissions and supporting volunteer groups have been responsible for resident interest surveys, program promotion, establishing short and long range goals, budgeting, selecting project sites, generating tree lists, planning Arbor Day programs, and, in smaller communities, actually planting the trees. The importance of the role that these commissions and volunteers play in the total community forestry process cannot be overemphasized. According to Steve Schwab, Salt Lake City Forester (1988), **"if the program is to succeed, the advisory board <u>must</u> provide the continuity necessary to sustain the program over an extended period of time."**

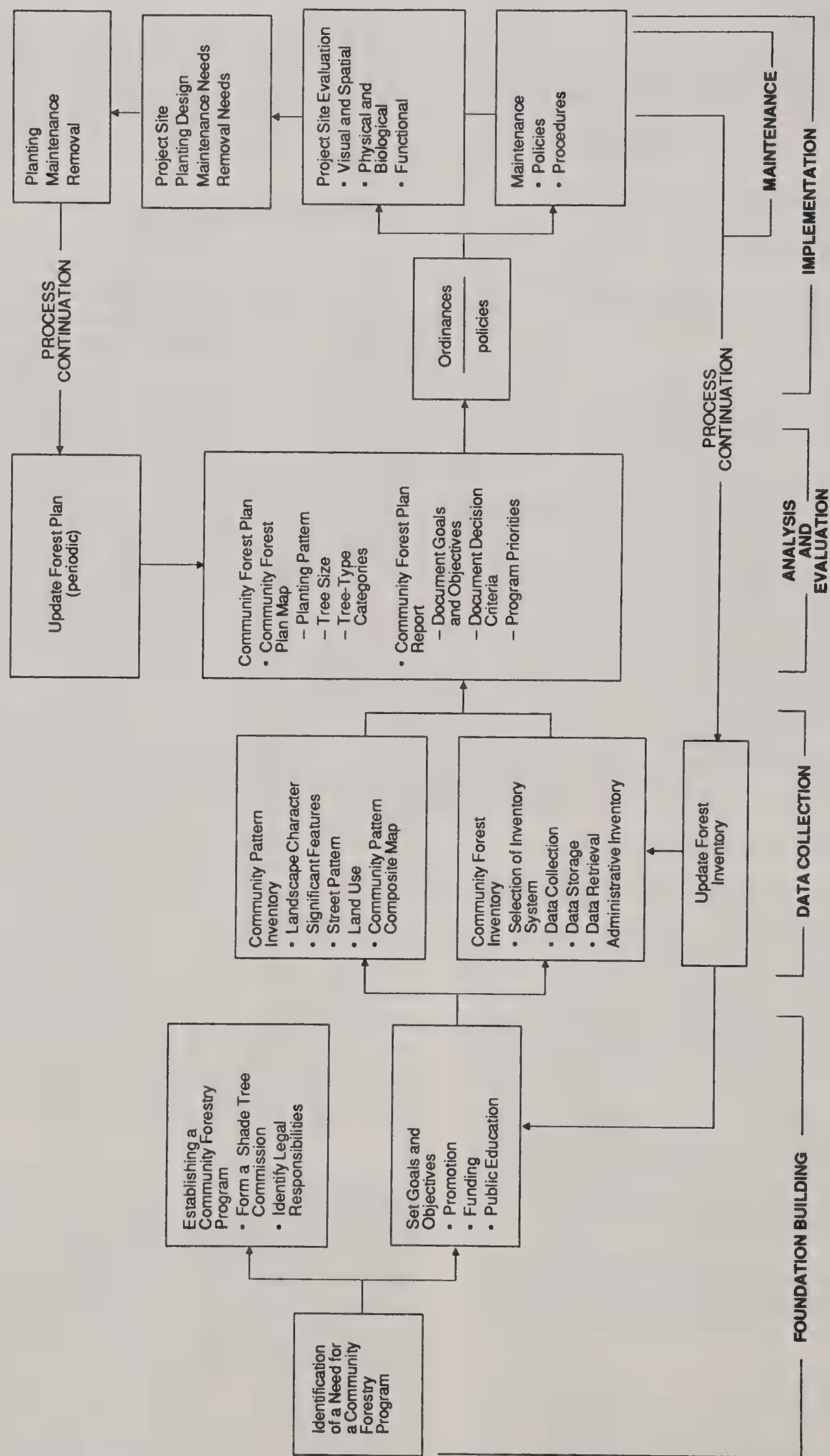

Figure 1-3. Community Forestry Process Diagram

The consensus of urban foresters responding to an urban forestry questionnaire identified three program elements of primary importance in foundation building. First, the program must be promoted through public education and involvement. Enlisting media representatives in promotion helps reach and galvanize public interest.

Second, the legal boundaries which define community and citizen responsibilities related to the forestry program have to be established. Third and perhaps most important of all, the commission, with community input, should develop strategies to finance the community forestry program on a continuous basis.

Data Collection

Once the Shade Tree Commission has been organized and has constructed the necessary foundation for the program, it may focus efforts more directly on the community's forest resources. The staff of the Shade Tree Commission (or a consultant) should inventory the community pattern in terms of landscape character, land use, and street features to determine tree planting needs.

An assessment of current tree care activity is suggested to compliment the pattern and tree inventory. Tree management plans and policies, personnel and contractors, expenses, and equipment should be listed and assessed. A knowledge of existing activity and operations is baseline to program development or improvement.

This should be combined with an inventory of the existing community forest, specifically recording tree location, condition, value, maintenance and replacement needs, and the potential for expanding the community forest. In response to queries about tree inventories, community forestry respondents emphasized the need for accurate, detailed, and current inventory information upon which to base forest plan recommendations. Communities will need to select those inventory, analysis, and evaluation techniques best suited to their personnel, time and financial resources.

Analysis and Evaluation

The Shade Tree Commission's recommendations about the future of the community forest should be incorporated in the Community Forest Plan. The Community Forest Plan has two components that evolve from analysis and evaluation:

1. The Community Forest Plan Map

2. Community Forest Plan Report

Decisions about the location of new and replacement plantings, planting pattern and tree types are made during this phase of the process. These decisions are illustrated on the Community Forest Plan Map. The criteria used to make decisions about the planting pattern and species to be planted are recorded in the report portion of the plan. A tree ordinance, policies, and a prioritized list of planting and maintenance projects within the constraints of an annual community forestry budget are also included in the report. The Forest Plan is drawn to meet previously stated goals and objectives and serves to guide both short- and long-term management of the community forest. This comprehensive Forest Plan is central to any successful community forestry program. Many questionnaire respondents attribute the failure of community forestry programs to the lack of a long term plan.

Public review of recommended plans should be an integral part of the planning process. Because the Forest Plan is only a guide, it will need periodic revision as the community changes.

Implementation

The purpose of the implementation phase is to accomplish in a logical sequence the goals and objectives reflected in the Forest Plan. A shade tree ordinance is an implementation document that provides legal support for the Forest Plan. The ordinance developed by the Shade Tree Commission should reflect the community's needs and desires. Like the Forest Plan, the ordinance will require periodic review and revision.

Once project sites have been designated, the commission, qualified volunteers, staff, consultants or technical advisors will be involved in a detailed analysis of the project site. Basic tasks in this phase include analyzing the site and developing a planting plan. This is followed by properly ordering, inspecting, planting and establishing the trees.

The Shade Tree Commission should develop programs, policies and procedures for the continued maintenance of the community forest. In smaller communities the actual maintenance may be the responsibility of commission members and supporting volunteer groups. However, in most communities the maintenance will be done by city personnel or by private, contracted maintenance companies under the supervision of the commission or city agencies. Phil Hoefer, Urban Forestry Coordinator for the Colorado State Forest Service, speaks for a majority of urban foresters

when he suggests that many promising community forestry programs fail because they do not: (1) prepare annual written work plans, (2) host annual training sessions for city employees responsible for the tree care, or (3) prepare good specifications for tree care (1988).

Although the process of community forestry as described is organized in a linear way, it must be remembered that many of the above mentioned activities will be going on simultaneously once a community forestry program is in operation. For example, a tree ordinance is usually developed after the Forest Plan Map is completed, but it is included in the Forest Plan Report. Factors such as funding levels, public support, elected officials, community growth rates and natural phenomena will change over time. Consequently, the process outlined should be visualized as a flexible framework that will assist the community in responding to the dynamics of change.

The ultimate goal in community forestry is effective tree care programs to sustain healthy tree cover for many more cities and towns in the United States. Thus continuing programs are needed to plant, maintain, perpetuate, and remove publicly-owned trees and to provide guidance and information for the care of privately-owned trees.

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II. HISTORICAL BACKGROUND

Early History
Community Forestry in Utah
Community Forestry in Southern Idaho

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Early History

Mankind's religious and aesthetic attachment to trees predates the dawn of civilization and continues today. Recorded evidence of this relationship is found in Egyptian, Persian and Greek literature and art which beautifully celebrates the sacred grove concept in describing and depicting parks and gardens.

These early beginnings of tree planting were elaborated upon and advanced by succeeding generations and different cultures. The design renaissance in Italy and France (from about 1400 to 1600) produced formal designs in which trees were generally utilized as architectural elements to define outdoor spaces. During the later English Romantic period (from about 1700 to 1800), trees formed the design structure essential to creating landscapes which replicated the informality of the rural English landscape. The Renaissance and Romantic styles of design, more than others, have influenced the design direction of urban forestry in North America.

Planting trees for landscape effect in North America began in earnest in the early 18th century (Newton, 1971). During the preceding century settlers had been preoccupied with clearing off the wilderness for fields, homes and villages. It wasn't until the early 1700's that New England town squares were converted from pasture land to park settings with lawn and trees. In the southern colonies elements of the formal Renaissance style influenced planting around plantation estates. Thomas Jefferson utilized his architectural and horticultural knowledge to design the campus for the University of Virginia, which remains today a classical masterpiece. Jefferson was also instrumental in employing the French Architect, Pierre L'Enfant, to design Washington D.C. in the classical style, using trees to reinforce a hierarchy of streets, roads and urban spaces.

Andrew Jackson Downing, an early American spokesman for the Romantic style, discussed the basic romantic design ideals in his book *A Treatise on the Theory and Practice of Landscape Gardening Adapted to North America.* Downing's ideas had a tremendous influence on the design of public parks and private estates.

A later generation of foresters and landscape architects — including Bernard Fernow, F. L. Olmstead, H. W. S. Cleveland, Charles Eliot and others — became influential proponents of the need for planning, long-term plans for conserving existing trees and planting new ones in urbanized environments. Their successful design projects, such as Central Park in New York City, and their prolific writing generated public support for plans and projects which improved the quality of the urban environment.

The ideas expressed by these spokespersons took hold. Citizens and special interest groups began to support urban beautification projects, in particular the planting of trees. In 1872, J. Sterling Morton, a Nebraska farmer and politician, proposed the idea of Arbor Day, which has since become a national observance. Numerous village or rural improvement societies began to spring up across the country. As J. B. Jackson notes in *American Space,* "It is to the efforts of these men and these organizations that we owe those characteristic American landscape compositions of unfenced lawns and rows of uniform trees flanking a thousand small town residential streets and country roads" (Jackson, 1972, p. 37). In recent years, professional organizations such as the Society of American Foresters, the American Forestry Association, the International Society of Arborculture, the Arbor Day Foundation, American Society of Landscape Architects, and the World Forestry Center have provided guidance and information to community forestry programs.

As we shall see, these characteristic American landscape ideas were to be transplanted from the east and midwest and established in the Interior West by the first white settlers.

The history of community forestry in the Interior Western states is the history of individuals and groups who planted and maintained trees along streets, in parks, and other public spaces. Unfortunately, just as many of these pioneer community forests are now in decline and fading from the scene, so too is our knowledge and appreciation of the men and women who planted them.

Rediscovering the historical roots of a community forestry program could provide the spark that ignites a renewed effort or helps sustain the present one. The place to begin is the community or county library. A discussion with the local librarian may direct you to a book or to a previously compiled source of information. A phone call or visit to the state archivist often produces valuable results. Many state universities, such as Utah State University, maintain archival collections of photographs, maps, and other

material evidence of community forestry efforts. State foresters, extension foresters, and horticulturists at state universities or at the state capitol often have historical information tucked away in their files. Interviews with senior members of the community, particularly those who may have been active in garden or service clubs, can also provide valuable insights. Likewise city, county, and state historical societies, arboretums, public gardens, and museums may assist with much the search. Pooling information from all these sources should provide the information necessary to write a brief community forest history.

white settlers, the Mormons. When the Mormon pioneers left the Midwest on their trek westward in search of a new home, they brought with them memories of lush green landscapes. Their decision to settle in the valleys of the Great Basin — a vast arid and essentially treeless landscape — left many of the pioneers heartbroken and homesick.

The visual and spatial contrasts between the Midwest and the Great Basin could scarcely be more extreme and may well have been a factor in the early directives from Brigham Young and other early church leaders to begin adopting Joseph Smith's plan for the City of Zion immediately.

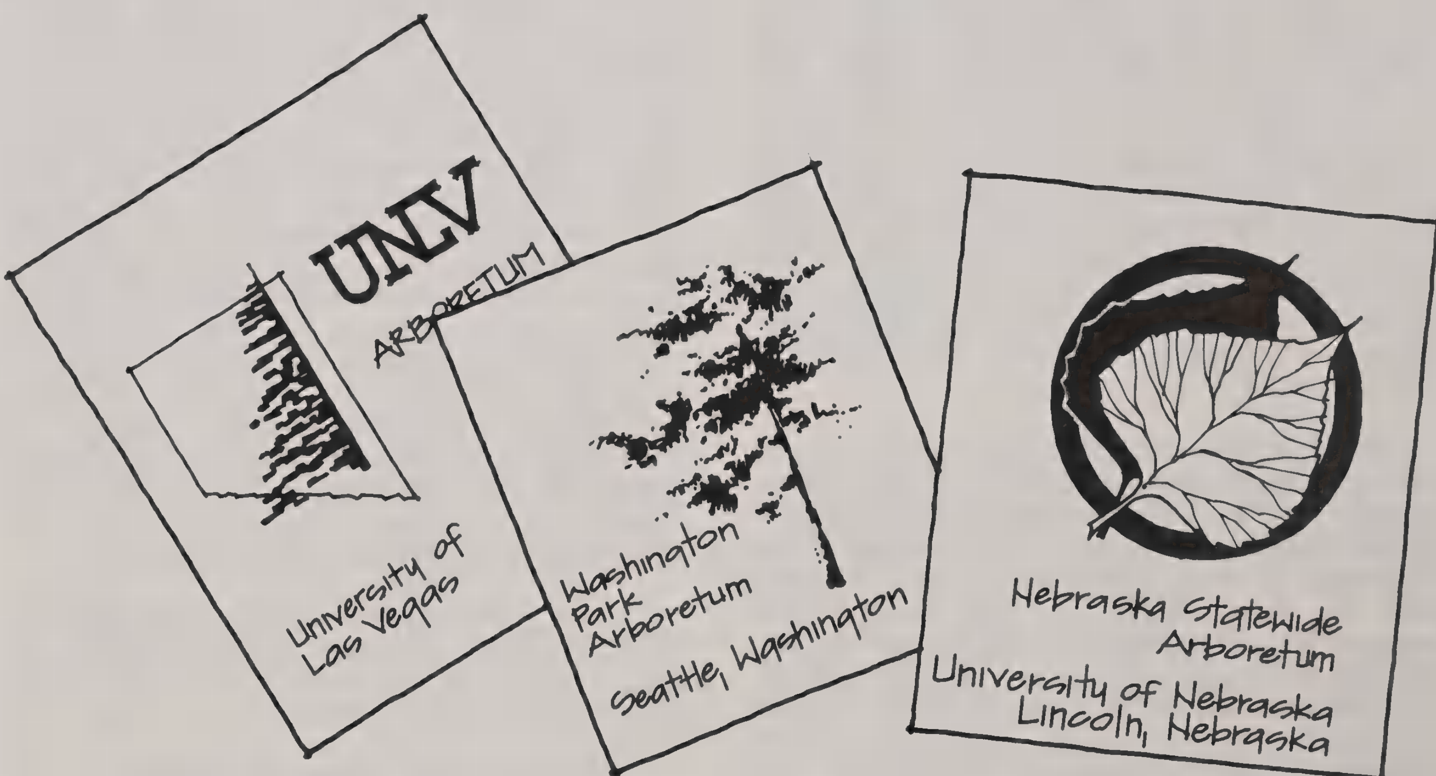

Figure 2-1. Arboreta and Public Gardens — Special Tree Information Sources

What if a community has never had a community forestry program or has no history to write about? There is no better time than the present to start a program; this manual will tell you how. Just remember to keep good records so that 50 years from now the record of your efforts can inspire the next generation to carry on the tradition and keep the trees growing. The following brief histories from Utah and Idaho illustrate the possibilities.

Community Forestry in Utah

The practice of planting trees in public spaces is deeply rooted in the history of the area's first

The philosophical idea behind the City of Zion was to create a Garden of Eden: "Make waste places blossom as the rose and the earth to yield abundantly" (Arrington, 1966, p. 25). Smith's concept included precise plans for the city with descriptions of block and lot arrangements, street widths, building setbacks, location of public buildings and community size. This very classical idea was superimposed on the desert landscape.

As the Mormons laid out streets, subdivided blocks, and dug irrigation canals, those pioneers also began planting orchards, vegetable gardens, and street trees from seeds they had brought with

them. "To assure uniformity, the city council passed an ordinance requiring holders of lots to set out trees for the improvement of the city in front of their lots" (Schuster, 1967, p. 90). Lombardy poplar, black locust, ailanthus, mulberry and willow were the predominant shade trees used. Figure 2-2 shows how shade trees were planted between the street and the building setback line adjacent to the canals.

The pioneers were instructed to make the desert bloom, and from numerous accounts of visitors to the City of Zion (Salt Lake City), they were successful. A number of visitors described the city as an oasis, magnificent and beautiful.

They commented frequently and favorably on a city ordinance requiring buildings to be placed 20 feet back from the front line of the lot. This required setback left ample space for shrubbery or trees and for the canals on each side of the street which irrigated the planting. As one observer said, "The streets are lined with trees while streams of running water course down each side of every street. Locust, maple, and boxelder are the favorite shade trees, and they grow luxuriantly" (Glazier, 1886, p. 441).

In the mid-19th century, Salt Lake City was the cultural center of the Mormon influence, which included the Intermountain West from Canada to Mexico, most of the Great Basin east of the Sierras and the desert Southwest to San Bernadino, California. It became the model community after which subsequent Mormon settlements in remote valleys were patterned. Consequently, street tree planting became an accepted practice in all new Mormon settlements and many non-Mormon communities throughout the West.

Utah and Idaho settlers were a tree planting people from the beginning. They brought a wide variety of shade and fruit trees into each new settlement. They established nurseries and soon began propagating trees best adapted to the climate.

Growth and prosperity brought more settlers to Utah. Rail and mining towns sprang up and although they were settled primarily by non-Mormons, they repeated the pattern of street

Figure 2-2. Pioneer Tree Plantings in Salt Lake City

planting established by the Mormon pioneers. These new settlers brought with them new tree species. Horsechestnut, maple, ash, and sycamore were added to the list of popular street trees. Throughout the Great Basin, the planting of orchards and shade trees along streets, in parks and around public buildings became an integral part of community growth and development.

The small communities scattered throughout the Intermountain West, the Great Basin, and onto the Snake River Plateau became green oases in the otherwise treeless landscape. Fingers of trees like spokes from a wheel spread out into the agricultural lands as hedgerows and windbreaks along the irrigation canals. These plantings added a new visual and spatial dimension to the Interior West.

Because of the obvious benefits derived from community forestry, several cities began to formalize their programs. In 1923 the Salt Lake City Shade Tree Commission was established and in recent years revitalized. It was given the responsibility for planning street tree plantings, selecting species, and directing maintenance of the city's urban tree resource. In succeeding years, other communities established similar commissions.

From the 1930's to the early 1960's, urban growth in the Intermountain West continued at a slow but steady rate. All the while local shade tree commissions, extension service experts, horticulturists, foresters and landscape architects worked together as advocates for community shade tree planting programs. LaVal Morris, Ernest Reimschussel, Arvil Stark, Fullmer Allred, Carl Johnson, Gary Merrill, Steve Schwab and others offered their expertise and assistance in selecting and planting trees in newly developed areas and for replacing older street tree plantings that were dying from old age.

Community Forestry in Southern Idaho

This discussion of community forestry in Idaho is excerpted from *A History of Community Forestry in Idaho*, by Gordon Bowen, 1981.

The original white settlements in Idaho were few and scattered. They consisted of trading posts, mission settlements and several Mormon communities in the southeastern corner of the state. A surge of new development came with the miners and mining operations in the 1860's. In the mining towns "boom psychology" paid little attention to community planning or beautification.

Many of the early mining towns and miners vanished when the ore gave out. A few miners, however, remained and took up farming, ranching or a trade. "Railroad towns" such as Pocatello, Montpelior, Hailey and Nampa became regional service centers. Permanent settlements began to develop. With permanence came concern for the quality of community life. This quote from *The Statesman*, a Boise newspaper, indicates that tree planting was seen by the citizenry as a key element in improving community appearance.

> The tree mania prevails in this city. Almost every street is already ornamented with poplar, cottonwood and willow trees. We flatter ourselves that we will be the premium or Star City of the plains when the water ditch is completed. The trees set out make a marked change in the appearance.

As the quotation above indicates, the initial tree plantings were almost entirely of readily available native species. Fruit trees were later brought into the area and planted extensively. Nurserymen introduced shade trees along with the fruit trees. Popular species included Silver Maple, Black Locust, American Elm and Sycamore.

Idaho communities other than Boise were concerned about their appearance. The influence of the Mormon "City of Zion" ideal had its effect on southern Idaho communities: "For many years Blackfoot has been referred to throughout the state as "Grove City" because of its beautiful and old shade trees. Rexburg is a city of attractive appearance...the streets are wide and bordered with trees" (Bowen, 1981, p. 14).

It seems evident that hot, dry summers caused these and other Idaho communities to plant shade trees at a very early stage of urban development. Diaries and journals of the times make frequent reference to shade, cool streets and walkways.

Several Idaho communities formalized the idea of shade tree planting by adopting Shade Tree Ordinances. In 1952 the City of Boise adopted Ordinance No. 2142, the first modern tree ordinance in the region. This progressive ordinance has been a model for communities throughout Idaho and the Northwest.

Idaho, like Utah, had its tree planting advocates, including Emil Grandjean (Swiss born forester), John Dominick, Gordon Bowen, Herman Ward, Roy List, Steve Churchillo (Boise City Foresters), Roland Portman, Anthony Horn, and Vern Burlison (State Extension Specialists). The efforts of these and other men and women have

improved the quality of life of numerous Idaho communities.

In recent years the rapid pace of development, tight community budgets and increased costs have led to a decline in new and replacement tree plantings in many Interior Western communities. The visual, social and economic benefits of shade trees enjoyed by previous generations are in jeopardy unless the tradition of shade tree planting is re-established.

A new generation of community foresters, landscape architects, horticulturists and extension specialists in both states are going to work on these problems. With public support communities throughout the Interior West will continue to bloom.

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III. BENEFITS

- Aesthetic
- Social and Psychological
- Recreational
- Urban Wildlife
- Economic
- Physical
  - Solar Regulation
  - Wind Regulation and Ventilation Control
  - Humidity Control
  - Temperature Control
  - Air Quality
  - Auditory and Visual Screening
  - Erosion Control
  - Traffic Control

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BENEFITS

Why should a community plant trees, especially when so many other demands are being placed on the budgets of cities and towns today? This question is not easy to answer and often the reply that trees will make things look pretty is not justification enough. Instead, urban foresters, landscape architects, and horticulturists must often resort to economic arguments in order to get their message across and justify their program. Such arguments often include a cost/benefit rationale to justify the costs of planting and maintaining a tree by quantifying the benefits that the tree provides. However, many of the benefits of trees are difficult to quantify. Yet, with the past, current and continued research to measure the value of these benefits, the worth of trees to our communities is ever increasing. Documented dollar values are being established and supported by researchers.

As one example of what some consider to be the value of trees, in 1985, the American Forestry Association made rough estimates of a tree's value for a few of its ecological contributions to homeowners and taxpayers. The Association concluded that, yearly, an average fifty-year-old urban tree would supply air-conditioning worth $73, soil erosion and stormwater control worth $75, wildlife shelter worth another $75, and air pollution control valued at $50. Total value in 1985 dollars was $273. Total value during the trees lifetime, compounded at 5 percent for fifty years equals $57,151 (Ebenreck, 1989). Dr. James Kielbaso of Michigan State University, one of the lead researchers in the National Urban Forest Council survey, estimated in a 1988 study on the management of urban forests that U.S. municipalities contain 61 million street trees. For every tree on the street, there are at least 10 more in parks and on private lots. (There are even more if small trees in the understory are counted.) That means a forest of 610 million city trees. In addition, the American Forestry Association's street-tree quotient – a measure of potential street-planting space shows, from measurements in 15 cities, that an equal number of unplanted tree spaces are available to those planted (Moll, 1989)j.

An estimated 610 million city trees with a potential benefit value of $57,151 each is an enormous benefit. Regardless of the exact dollar benefit, just the potential street-tree benefit could be doubled if the remaining available street-tree spaces were filled in our cities.

Figure 3-1. Trees Moderate Harsh, Paved Environment

Several sections of this chapter deal with both the tangible and intangible benefits of trees and woodlands in urban settings. Aesthetic, social, recreational, ecological, and economic benefits to urban residents will be examined as well as the ways in which trees can help improve the physical environment in even the most urban settings.

Aesthetic

Perhaps the greatest error a community can make is to not fully realize the potential impact trees can have on both the physical attractiveness and social fabric of a community. The colors, textures and forms of trees provide a visual mosaic of contrasts within an urban environment. They introduce the shapes and color of nature into the angular, artificial, man-created geometry of roads and buildings.

Trees should be viewed, by residents as well as urban foresters and landscape architects, as an integral part of the total three-dimensional urban structure. Trees used to frame or enhance views add interest to a landscape. They heighten the sense of enclosure and perspective, thereby creating an impression of more or less space (Clouston and Novell 1981). They can give definition and meaning to spaces between buildings (Patterson 1977) and create a sense of unity within an urban setting by reconciling widely divergent architectural styles.

Trees may be used in a variety of ways to enhance the aesthetics of an area. Single trees can serve as specimens, as in an arboretum. Individual trees may also have historical significance, such as those planted to commemorate individuals or deeds significant to the community. These distinct specimens, or trees of special character, can be used for formal ornamental purposes as living sculptural elements in town squares, parks or courtyards (Patterson 1977).

Trees planted in groups may serve more aesthetic or functional purposes, such as screening undesirable views in parks, greenbelts, roadsides and forests. These groups may consist of pure or mixed species, be even- or uneven-aged, and be naturally occurring or planted (Noyes 1970). Many of the most significant examples of this in the Interior Western states are the avenues district and Temple Square in Salt Lake City, Main Street in Brigham City and Ann Morrison Park in Boise.

The belief that a planned urban forest will appear "contrived" and less "natural" than random development is a mistaken one. The importance of proper planning cannot be stressed enough when dealing with aesthetic considerations. Because trees are dynamic rather than static ornamentation, a poorly planned planting will detract from rather than enhance the aesthetic appeal of a community. Urban planners must have a firm idea of the purpose of an area and select trees which are compatible with the existing spatial and locational requirements of the site (Noyes 1970).

According to Noyes (1970), there are certain visual characteristics which allow us to identify, classify and appreciate trees. These include (a) color (foliage, flowers, bark); (b) shape (outline of crown, branching habit); (c) texture of foliage (open- or dense-textured); (d) tone (variations in color); (e) light reflection (dark colors absorb, light colors reflect); (f) size (height and diameter); (g) growth habit (single stems or clumps); (h) shade tolerance (effect of competition) and (i) time (as related to species composition, ecological relationships, size and shape development).

Other factors which relate to appearance include distance, light, topographic form and contrast, spatial definition, observer position and sequence. Noyes emphasizes that the common component in all this is variety, or relief from monotony, and that this is the key requisite of aesthetics. Beatty (1985) states that aesthetic benefits are broad and that "...visual fitness of trees is best related to land use, size and scale of landscape space, year-round effects of foliage, and form of trees relative to intended use." Avoid the "beautification syndrome" in which only the short-term effects are emphasized.

Social and Psychological

Trees not only enhance the visual quality of a community; they also make an important contribution to its social quality as well. In the 19th century, the planned inclusion of trees was seen as beneficial to the health and morality of the working class. In 1844, the New York Board of Health defined trees as improvers of city air and encouraged their planting in urban areas (Clouston and Novell 1981). Recently, the psychological benefits of natural environments have been shown through monitoring the physiological responses of individuals exposed to different settings. Natural environments are much more effective than man-made settings in reducing heart and breathing rates, promoting relaxation and recovery from stress (Schroeder 1986).

More recently, research has shown that urban dwellers place a high importance upon trees located along residential streets, especially in areas where few trees are planted in private yards (Schroeder and Cannon 1987). In fact, the visual prominence of street trees is the greatest single

positive predictor of street attractiveness. Usually, it is the large, old trees in these locations which residents and visitors value the most; however, from a management or planning point of view, these trees are often not as desirable because they are difficult and expensive to maintain properly (Schroeder and Cannon 1983).

To ensure successful urban plantings, particularly in inner city areas, requires that a community or neighborhood be involved in planting and maintaining the trees. From this the neighborhood develops a sense of personal interest in and concern for the trees' development. This strategy has worked well in inner city areas of Oakland, California where the establishment of local shade tree commissions and the resulting community participation has gone far beyond just increasing the survival of urban plantings. It has increased residents' pride in their community and fostered a sense of public awareness which has encouraged them to participate in other projects such as community gardens, cleanup parties and neighborhood protection organizations (Ames 1980).

The importance of trees to social health should not be neglected by urban planners. Rather, urban forest planning should focus on the needs of the people in the community while also striving to maintain its unique character (Beatty 1985).

Recreational

People desire urban greenspace which introduces flowers, grass, trees and open space into the monotony of the modern environment (Gold 1986, Airola and Wilson 1982, Kaplan 1981). As population growth creates more urban sprawl, the amount of available greenspace for recreation, whether developed or undeveloped, is curtailed. This places increased pressure upon that space which remains. Unfortunately, this increased pressure often has the effect of further reducing the desirability of parks and recreation areas already overburdened by use and hampered by lack of adequate planning and funding. As parks and recreation areas depreciate, the threat of vandalism, pollution and user safety in the remaining areas increases (Loeb 1987).

As mentioned previously, the social and psychological benefits of urban vegetation may be significant and, in conjunction with this, providing adequate urban greenspace for recreation serves as an outlet for realizing these benefits. Recreation is defined by Airola and Wilson (1982) as involvement in certain types of outdoor experiences which yield personal benefits of pleasure, a sense of accomplishment and creative expression to the participant. Such activities may be physically passive or active. Recently, Gold (1986) demonstrated that parks with more informal, natural and diverse landscape characteristics have a more positive influence on user satisfaction than those with less natural, more formal and sterile landscape character. Gold also found that vegetation, or lack of it, is an important component of environmental quality and the recreational experience. Therefore, vegetation can determine the level of use in an area. Airola and Wilson (1982) caution planners that residual or undeveloped open space must also be considered in planning because this space may provide recreational benefits which cannot be obtained in more formal parks or open spaces.

Figure 3-2. Trees Provide Settings for Socialization

Schroeder (1983) discovered that users tend to separate into two distinct preference groups. He finds that those people who have spent most of their lives in urban areas are more likely to prefer developed parks whereas those who have spent most of their lives in the suburbs or rural areas prefer natural forests or settings. Recreation

planners must take such preferences into account and plan the design of urban recreation areas to maximize their appeal to a wide spectrum of users.

An unimaginatively planned park is impotent and unattractive to users (Airola and Wilson 1982) and may create a sense of alienation in nearby residents, resulting in indifference towards trees, plantings and park space in general (Johnston 1985). This indifference can be strongly reinforced if there is a lack of public input into the planning and execution of public recreation projects. On the other hand, where such consultation has been sought prior to a park's establishment, public response has been both enthusiastic and supportive (Johnston 1985, Kaplan 1981). This support can significantly reduce vandalism, improve contact between residents and personalize the landscape so that residents gain an important sense of control over their conditions (Johnston 1985).

All of this indicates that resident involvement in community recreation planning should be a major objective in urban forestry policy. As Payne (1983) states, managers need to learn about both those people who use current recreational facilities and those who do not. These managers should regard public input as support rather than interference.

An example of what can successfully be achieved in urban planning is the City of Oslo, Norway, municipal forest, or Oslomarka. This multiple use facility surrounding the Norwegian capitol provides the city's drinking water, serves as a recreation area for over one million visitors per year (1984), and provides approximately 4.5% of the country's total pulpwood supply and timber sales from its forest area, valued at $40 million (US dollars) in 1984 (Mjaaland and Andresen 1986). Similar endeavors undoubtedly exist in the western U. S., however, none are widely publicized. The Oslomarka does serve as an excellent example of what can be achieved when urban planners, citizens and politicians come together and decide to reconcile the often conflicting facets of forest management, outdoor recreation and nature conservation.

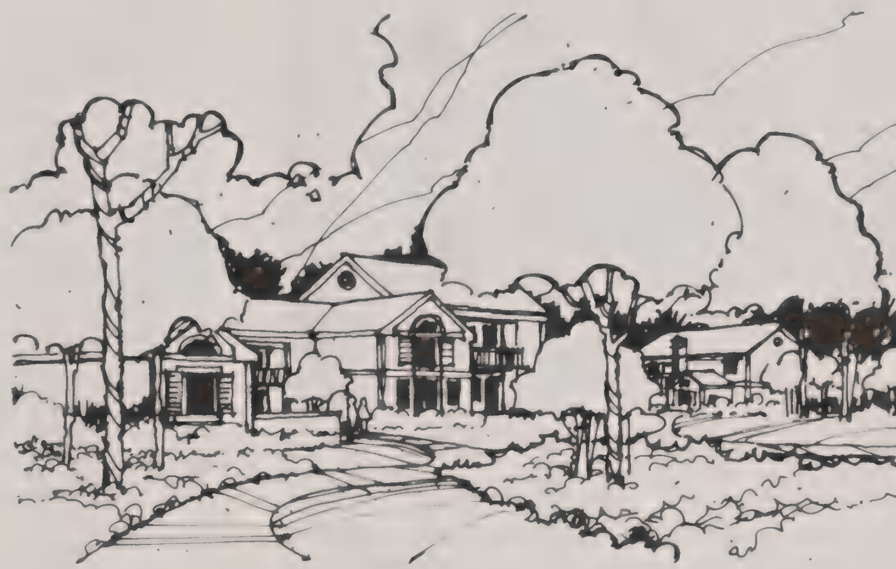
Urban Wildlife

As planners and builders modify landscapes in order to integrate them with human needs and facilities, they have a responsibility to maintain a standard of livability for humans while allowing for the flora and fauna of the natural environment. Diverse communities of plants and animals in cities contribute to the overall health of an urban ecosystem and are important indicators of the city's habitability for humans.

A number of recent studies (Davis 1973, Kellert 1985, Shaw *et al.* 1985) have indicated that people enjoy and appreciate wildlife in their day-to-day lives. A 1980 nationwide survey of wildlife-related recreation (Shaw *et al.* 1985) found that 55% of respondents interact with wildlife species near their homes by either watching, feeding, photographing, or painting them. A survey in Seattle (Dick and Hendee 1986) found that 90% of those questioned responded that the presence of wildlife enhanced their visit to a park, even though wildlife watching was not their primary reason for going to the park.

A recent study (Black *et al.* 1985) confirms that people who live near natural areas in urban settings develop a greater knowledge of and interest in urban nature. Similarly, an examination of Missouri voters who passed a 1980 bill providing for statewide habitat enhancement revealed that strongest proponents of the bill were people who had grown up in rural and semi-natural environments. The bill carried heavily in urban areas (Witter *et al.* 1981). People enjoy wildlife in their lives and the sense of feeling a connection with nature. Providing ready access to natural areas and the opportunity for citizens to learn about them can, over the long term, generate a constituency that is supportive of urban open space and of urban wildlife habitat conservation.

- BUSINESSES FLOURISH
- PEOPLE LINGER AND SHOP LONGER



- APARTMENTS AND OFFICE SPACE RENT QUICKER
- TENANTS STAY LONGER

- PROPERTY VALUES INCREASE
- NEW BUSINESS AND INDUSTRY IS ATTRACTED

Figure 3-3. Treescapes in Business and Residential Areas Stimulate Customer and Tenant Activity — National Arbor Day Foundation

Among the strongest points in favor of urban wildlife conservation is cost-effectiveness. Habitat creation and enhancement complement many of the beneficial functions of the urban forest discussed in this chapter. The chief benefit of urban wildlife habitat is that it is not an extra concern to be added on to all of the other community goals; rather, it is an integral part of the existing community planning and management framework.

Economic

Urban development can be profitable for some; however, urban sprawl destroys greenspace. Trees, and urban greenspace in general, seem to require some sort of tangible economic justification for their continued existence and preservation. Why? Because the benefits of trees are not well-known and are difficult to quantify. Therefore, these benefits are not given enough weight in the decision-making process or they are ignored completely. According to Payne (1983), this is a problem of valuation (if viewed by an economist) or perception (from the perspective of a sociologist, psychologist or outdoor recreation specialist).

We can classify economic benefits into two categories. Those which show some promise of having a quantifiable, tangible value associated with them, and those which are very difficult to evaluate and remain, essentially, intangible. Despite the seeming impossibility of placing a monetary value on a scenic vista, or the aesthetics of a tree-lined avenue, or the psychological benefit gained from spending a lazy afternoon watching children play in the shade of a park tree, some researchers have attempted it. For example, Lien and Buhyoff (1986) feel that to demonstrate tangible benefits of urban trees, one must show that their scenic values can be measured and, consequently, predicted as a result of differences in vegetative structure. Their results indicate they can establish a relationship between scenic quality and measurable parameters of urban trees (ie. basal area per stem, number of trees) particularly when average diameter is used as a variable. On a slightly different tack, recent work by Franks and Reeves (1988) has sought to develop a formula for calculating the value of an individual tree to a functioning ecosystem, as opposed to its value as ornamentation or timber. Such a system requires evaluation of the trees' significance pertaining to soil, nutrient, water, animal usage and habitat characteristics.

Other researchers have concentrated on attempting to refine a method for measuring the monetary value of parks and urban woodlands. Some of the more common methods used in the attempt to measure benefits include the following:

1. the travel cost method (the amount a user is willing to pay not to be excluded from a site);
2. the hypothetical, or contingent valuation, method (based on attitude/behavior relationships) and
3. the analysis of related market prices (land values of similar properties located near to and far from a desirable recreation facility).

Some researchers (Allen *et al.* 1985) caution that no single version of these methods may be valid for a particular study or is without flaws, but combining them invites the risk of double-counting benefits. Others (Dwyer *et al.* 1983) remind us that the essence of benefit/cost analysis is a public willingness to pay to use a facility compared to the cost of providing the opportunity to use it. It is not necessary for users to actually pay for benefits received, only to indicate that the benefits experienced by them are sufficient to justify an expenditure. Such methods are already used by economists and urban planners to justify funding for such facilities as arboreta, botanical gardens, conservatories, forest preserves and parks. On such a basis, More *et al.* (1982) conducted a study showing that the value of benefits from establishing urban parks (mainly in the form of increased revenue from assessments on property located near the park) in Worcester, Massachusetts greatly exceeded the annual operating costs of the parks.

Whoever planted rows of trees
Beside the roads and lanes,
God rest his soul in Heavenly peace
And bless him for his pains;
For he who gave of time and toil,
Who gave of heart and hand
To nurse the tender shoots that were
To shade the ways of man,
Was quite as great as those who built
Of stone and minted gold --
No need to cast his name in bronze,
His deeds need not be told.

--Stanley Foss Barlett

Despite such efforts, aesthetic, sociological and psychological values are still often difficult to quantify. Other factors such as the influence of trees on reducing building energy costs or improving water quality can be relatively easily shown to have a dollar value to residents (discussed in the section on physical benefits).

However, even the seemingly straight-forward exercise of placing a definitive value on individual trees or property (for insurance, legal or tax purposes) often poses difficulties even for researchers, professionals and appraisers.

Determining the value of individual trees to cities and homeowners (particularly for the purposes of litigation) is covered elsewhere in this manual. However, at this point it can be mentioned that the value of trees, unlike other municipal or personal assets, appreciates rather than depreciates over time. Hence, they can be creatively managed to produce an economic benefit to a community rather than be a net loss due to maintenance costs.

For example, trees create debris and this debris needs to be removed and disposed of at a cost to the remover. Cities and municipalities can recover a substantial amount of the removal costs by finding alternative methods to avoid paying the ever-increasing cost of landfill disposal. Miller (1988) suggests that trees requiring full removal, particularly if they are sound and of a desirable species, may be sold for milling as veneer-quality or sawlogs, or for use in furniture manufacturing. If of a lower grade, the residue may be sold as firewood — a particularly attractive option in larger urban centers where the price for firewood can be high. Branches and other waste pieces can be chipped for sale or used as mulch in landscaping or other city projects. All of the above options should be significantly cheaper than paying for disposal at a landfill, and they offer a potential for cost recovery. Urban woodlots in North America are not really managed for timber values, unlike Europe where many cities recover the cost of urban management programs through the sale of timber on those lands. Miller (1988) warns, though, that trees cannot be assessed as both forest products and amenity trees at the same time, but only as one or the other.

Figure 3-4. One City's Portable Sawmill Slabs an American Elm Log for Sale to a Specialty Furniture Manufacturer

Table 3-1. Value Increase Attributed to Trees on Both Developed and Undeveloped Residential Property Using Relative Sale Value.

Type of Property	Value increase by trees	Location of study	Source
Developed	7%	Amherst MA	Morales 1980
Undeveloped	15%	Amherst MA	Morales 1980
Developed	6-9%	Manchester CN	Morales 1980
Developed	$9 500*	Rochester NY	Morales 1983
	$6 000*	Rochester NY	Morales 1983
Developed	3-5%	Athens GA	Anderson and Cordell 1985
Undeveloped	6-7%	Athens GA	Anderson and Cordell 1985
Undeveloped	$1 500/acre	Columbia SC	Miller 1988
Undeveloped	27%	? MA	Miller 1988
Developed	7%	? MA	Miller 1988

* Valuation used was the CTLA method.

The way in which trees influence property values has been the subject of substantial investigation. The sample research findings compiled in Table 3-1 show increases of roughly 3 to 10% in the value of developed (single-family dwelling on a lot) and 6 to 27% for undeveloped property in a variety of locations. Lots with trees were also shown to sell sooner than those without, and the higher value leads to increased property assessments which boost municipal property tax revenues (Anderson and Cordell 1985).

Any method of land value assessment for trees must be applied carefully because a tree's value is derived from that of the property as a whole. Therefore, summing individual tree values using the Council of Tree and Landscape Appraisers (CTLA) or Tree Council of the United Kingdom methods (both discussed in the Inventory chapter) must be done with some caution so that the total appraised value for the trees on a site remains realistically proportioned to the total value of the property (Abbot 1986).

As with any discussion of economics, costs must be addressed. Urban trees have a real cost in terms of planting and annual maintenance. The benefits side of the valuation equation is often very difficult to evaluate and quantify. However, aesthetics and other social and psychological values do have a real, if somewhat nebulous, role in urban environment planning and must be taken into consideration. As indicated, the cost side of the equation can often be offset by careful planning and imaginative use of available resources.

Physical

Solar Regulation

Conventional wisdom suggests that in temperate climates deciduous trees are ideal 'natural' cooling and heating regulators for buildings, particularly houses and mobile homes. According to Heisler (1986), on a national average approximately 53% of the total energy use in houses is for space heating and another 12% for space cooling. This represents almost 8% of all energy use in the U. S. Wagar (1985) calculates that reducing home heating and cooling costs by 2% annually would save over one billion dollars in the U. S. alone. In general, a typical conventionally constructed house could save 20-25% of annual space energy use (Heisler 1986). In states of the Interior West, deciduous trees can be used to block excessive solar radiation during the summer while allowing sunlight to warm surfaces during cold winters.

To obtain maximum benefit, an 'ideal' tree would 'open' (leaf fall) when solar heating is first required and 'close' (leaf out) when shade became more desirable (Wagar 1985). In addition to foliation period, the characteristics that influence a tree's effect on irradiance include crown density, size, form and growth rate (McPherson and Dougherty 1989). The relative importance of these characteristics has been widely disputed. However, the effect of tree shade on the energy performance of a building is proportional to the amount of surface area shaded. Therefore, form, crown density, and perhaps most importantly, tree placement are the most significant determinants.

Perhaps surprisingly, planting trees on the south side of a house often increases energy costs rather than savings. This is true because trees on the south side of structures must be very tall in order to block the summer sun and, as such, they produce significant amounts of winter shade even after leaf drop. Even fully defoliated crowns can block 20 to 50% of incident solar radiation (Thayer and Maeda 1985, Heisler and DeWalle 1984). Researchers suggest that plantings located on the east and west sides of buildings offer the most advantageous combination of solar control and energy savings by blocking early morning and late evening sun in the summer but offering no obstruction to winter sunlight (Heisler 1986, Thayer and Maeda 1985, Wagar 1985). McPherson and Dougherty (1989) show that dense shade on west walls reduced annual energy costs by 10-12% for homes in the Southwest.

Another consideration in tree placement is the effect on homes equipped with solar collectors. Trees on both streets and private property should be located with an eye to keeping solar access to collectors unobstructed. Some states have now passed laws mandating unobstructed access of solar collectors and such considerations should be adhered to in any landscape plan. Thayer (1983) suggests that communities with plans to exploit solar energy should re-evaluate tree planting and urban forestry policies in order to reduce potential solar access conflicts.

In this vein of careful forethought and planning to maximize the aesthetics and energy considerations of tree placement, Parker (1982) introduces the concept of 'precision landscaping'. This concept involves detailed analysis of climate data and residential thermal and energy use patterns. Energy savings can be realized at different latitudes by the proper placement of trees to block incoming solar radiation; by creating a cool microclimate via evapotranspiration; and by arranging vegetation to best channel or block airflows. Several of these factors have been

Figure 3-5. Even Defoliated Tree Crowns Can Block Sunlight

modeled in computer programs designed to select the best locations and species for landscape plantings in order to provide a desired effect on a particular site.

The landscape plan illustrated in Figure 3-6 provides the following benefits.

1. Coniferous windbreaks are grown to block the strongest winter winds.
2. Trees on the east and west sides will provide summer shade.
3. A tree here will provide shade as the sun sets in midsummer.
4. A variety of deciduous trees to the south should grow tall and permit pruning of lower branches so that winter sun will strike the windows uninterrupted.
5. The year-round effect of foundation plantings seems never to have been measured, but they would be expected to be energy savers if they do not shade windows in the winter.

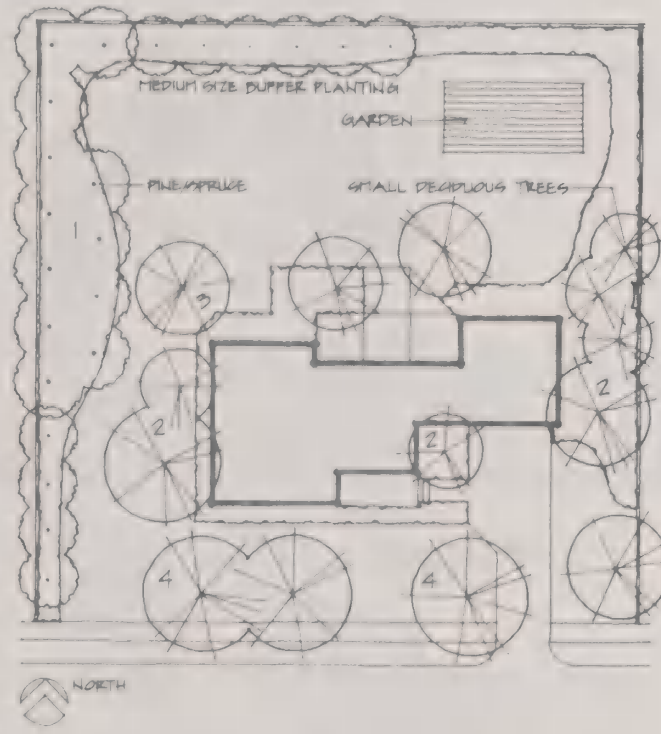


Figure 3-6. Landscape plan for a home site in a temperate portion of the country with prevailing winter winds from the northwest and summer breezes from a southerly direction

Wind Regulation and Ventilation Control

On hot summer days, gentle breezes may be a welcome way of staying cool. However in winter, cold winds can damage homes as well as increase heating costs. Trees, aligned into windbreaks, can moderate the effects of severe winds and may typically save from 10 to 12% of home heating costs, and up to 40% in older, non-weatherproofed houses or mobile homes (Heisler 1986). Usually, windbreaks are most effective if situated on the north and west sides of a house. This is the prevailing direction of winter winds in most Interior Western areas. The windbreak should be located away from the house at a distance 3 to 7 times the average height of the trees. It can be closer so long as it does not shade the house in winter (Heisler and DeWalle 1984).

Trees may also serve to divert wind away from structures or to areas where maximum cooling may be desired. Wind velocity may also be decreased by passing through a dense screen of foliage. Contrarily, windspeed can also be increased by using vegetation to constrict and channel airflow, thus creating a vortex effect (Miller 1988). As well, carefully located plant buffers can control drifting snow levels by accelerating winds over road surfaces to keep them clear (McPherson 1988).

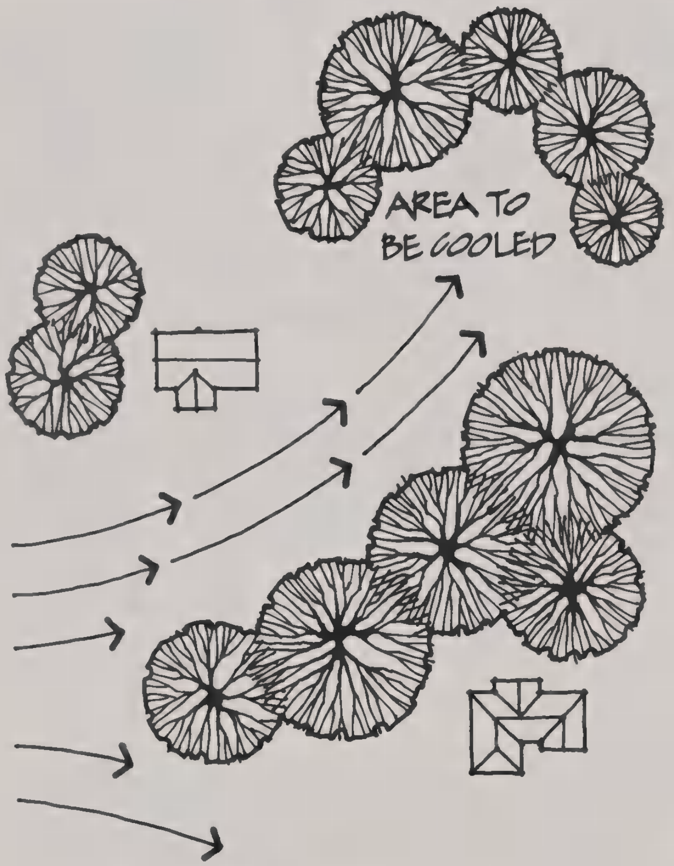


Figure 3-7. Plants May be Used to Guide and Accelerate Air Movement

Humidity Control

Although an individual tree absorbs its share of incoming solar energy and transpires from 50 to 100 gallons of water into the atmosphere on a typical summer day, still it does not modify climate significantly, but may change the microclimate. A stand of trees in a park or urban greenbelt, if considered over the entire expanse of a community, can significantly modify the environment. By absorbing the sun's energy and utilizing 60-75% of the amount captured in evapotranspiration, trees alter the relative humidity of their immediate vicinity and are 10 times more effective than grass in doing so (Bernatzky 1983). Of course, effective moderation of relative humidity in this manner depends on the trees having access to an adequate supply of water to continually release into the air, particularly during summer months when demand is high.

Temperature Control

Air temperature is controlled mainly through the factors mentioned earlier in this section: solar radiation, wind and humidity. With the exception of the area they directly shade, individual trees do not radically alter the temperature in an area. Collectively, however, a stand of trees can noticeably moderate temperature. Tree canopies block solar radiation and provide cooling shade. They also prevent direct sunlight from striking surfaces, slowing their heating and, thus, the amount of heat they store. This reduces the amount of long-wave radiation (heat) which can re-radiate back into the atmosphere during the day (in such man-made areas as streets and parking lots) and during the evening.

The loss of water by leaves during evapotranspiration helps to reduce air temperature under a forest canopy. Differences in temperature between shaded and unshaded areas may set up convection cells which create air movement. While not actually altering the air temperature, a gentle breeze may serve as a welcome psychological break to those feeling it. In brief, vegetative cover such as that provided by a forest canopy has the effect of reducing maximum and raising minimum daily temperatures. This serves to dampen the extreme variability in temperatures often found in an environment dominated by man-made structures, especially in the arid climate of the interior U. S. It also serves to enhance the appeal of mass plantings for physical as well as aesthetic reasons.

Table 3-2. Abilities of vegetation to remove pollutants.

Type of cover	Pollutant removed	Removal rate (tons/acre/yr)
Forest (unspecified)	Sulfur dioxide	0.16
Mixed woodland	Carbon monoxide	1.23
Mixed woodland	Nitrogen oxides	0.2
Lime Trees	Dust	22.4
Beech Trees	Dust	33.6
Grass	Dust	0.17
Clover	Dust	0.43
Soil surface	Dust	0.07

* Compiled from various sources by Madders and Lawrence (1985)

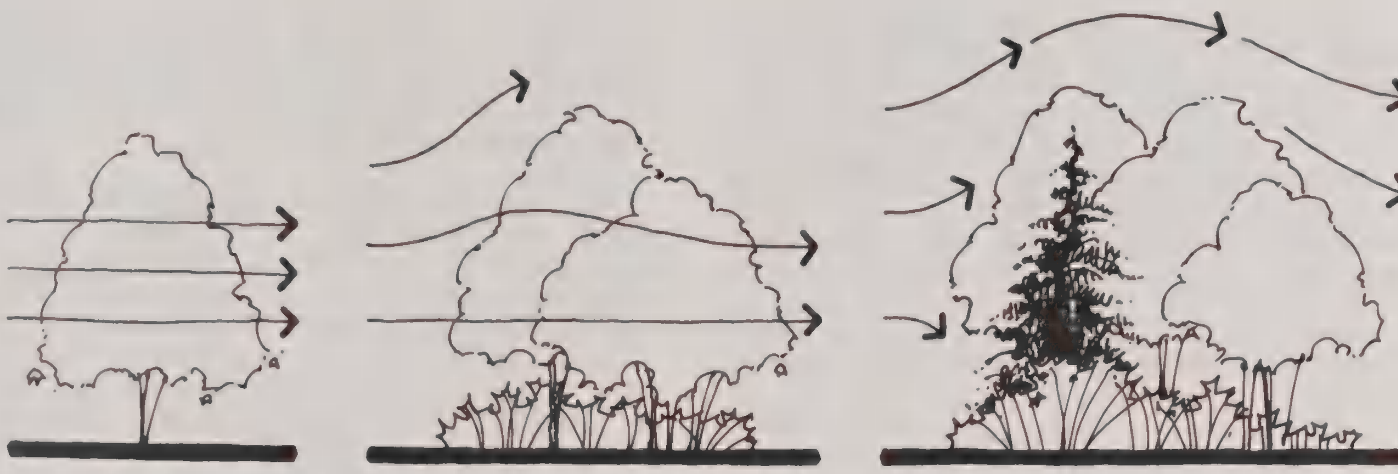


Figure 3-8. Buffer permeability. Buffers should be of a density suitable to remove the intended pollutant(s). (1) Very permeable: Minimum gaseous and particulate removal. (2) Moderately permeable: Maximum gaseous and moderate particulate removal. (3) Impermeable: Maximum large particle and minimum gaseous removal

Air Quality

The combination of climatological conditions, such as inversions, and a rapid increase in population has contributed to increased air pollution. Communities throughout the west, and particularly along the western face of the Wasatch mountains in Utah, and the eastern faces of the Sierras in Nevada and the Rockies in Colorado have recently experienced severe declines in air quality. Increased release of carbon monoxide and dioxide, hydrocarbons, nitrogen oxide, sulfur dioxide and solid and aerosol particulates into the atmosphere has debilitated many of the pristine features which attract people to live in the west.

High atmospheric dust levels can reduce sunlight intensity from 10 to 30% (Bernatzky 1983). This can depress the growth rate of agricultural crops and, consequently, lower yields. High pollution levels also increase the costs of cleaning city buildings due to deposition of airborne particles on windows, concrete, brick and other building materials. Acidic or chemically saturated rainwater can also deteriorate building surfaces (Madders and Lawrence 1985). Moreover, high levels of pollutants can pose serious problems for persons suffering from a large variety of respiratory ailments and other physically sensitive conditions.

Trees, when planted in quantity and variety, can greatly reduce atmospheric levels of particulate matter and airborne chemicals. Bernatzky (1983) reports that if a properly permeable planting is present, such as in a park, up to 85% of airborne particulates may be filtered out and up to 70% may be removed on a tree-lined street alone. Even in the winter, the plantings may retain 60% of their capacity to remove pollutants.

Three design principles for using open space in an air resource management program are outlined by McCurdy (1980). The first is **separation**. Open spaces can be planned to physically separate the source of the pollutant from the receptor. This buffer dilutes pollution by allowing a longer period of time for it to be diffused by wind direction and speed.

The next principle is **alteration**. Conditions can be changed to alter windflow patterns and, hence, the distribution of airborne pollutants. For example, wind passing over a shelterbelt slows on the lee side of the belt. This allows heavy airborne particles to settle out. **Removal,** the final principle, concerns the ability of vegetation, soil and water to act as sinks for pollution, thereby limiting pollution levels. The main methods of removal are gaseous uptake (absorption) and particulate deposition and impaction (adsorption).

To further examine the impact of one specific environmental effect, Madders and Lawrence (1985) focused on turbulence. Their research found that turbulence caused by any large, disruptive surface area (such as a buffer of trees)

affects polluted air in four ways: (1) it mixes and dilutes polluted air with less polluted air; (2) it deposits particulates and aerosols on leaf surfaces; (3) it allows gravity to settle particulates in less turbulent air on the lee side of vegetation, and (4) it brings toxic gases into close contact with the gas exchange systems of leaves and soil. Soil is considered the major sink for atmospheric pollutants.

Table 3-3. Ability of Soils to Absorb Air Pollutants.

Pollutants	Removal rate (lbs/acr/yr)
Ammonia	53.99
Carbon monoxide	1963.3
Hydrocarbons	0.48
Nitrogen oxides	19.6

Source: Madders and Lawrence (1985)

The permeability of a greenbelt is the primary determinant of its ability to remove pollutants (McCurdy 1980). For example, a moderately permeable buffer may provide maximum pollutant removal because of the large, exposed leaf surface area and increased amount of time air spends in the canopy due to reduced air speed. Conversely, an impermeable buffer may remove little in the way of gaseous pollutants but allow maximum sedimentation of particulates on its lee side. For detailed suggestions on selecting and planting tree species to maximize air quality benefits, see Miller (1988).

Of course, trees are not entirely immune from the effects of poisonous gases in the air. They too will suffer when levels become too high. Although there is no tree with absolute resistance to pollution, some woody plants are notably resistant (Bernatzky 1983). Another factor to consider is that due to their inherent method of respiration, trees produce and release oxygen into the atmosphere. This can serve to relieve the local oxygen deficits sometimes found in highly urbanized areas where a great deal of elemental oxygen is tied up as carbon monoxide/dioxide or in any of the nitrogen or sulfur oxides (Bernatzky 1983).

Auditory and Visual Screening

Auditory screening by using trees has been demonstrated to have some effect although often the level of effect is over-rated (Bernatzky 1983). Current research indicates that earth generally, and the forest floor specifically, absorbs low-frequency sound whereas the leaves and stems of dense vegetation tend to scatter high-frequency sounds that humans find particularly disturbing (McPherson 1988, Anderson *et al.* 1984).

In order for plantings to appreciably affect sound levels they must be at least 16' wide (Anderson *et al.* 1984). Forest stands may reduce sound levels up to 10 dB per 100' of buffer, but a reduction of 6 to 8 dB per 100' is more commonly achieved (Miller 1988, Leonard 1971). Equal or superior results (6 to 15 dB reduction) can often be obtained by using plantings in conjunction with landforms or in combination with solid barriers (5 to 8 dB reduction) (Miller 1988). The advantage of these systems is that they do not require the large amount of physical space that a vegetation barrier alone does.

As stated earlier in this chapter, strategically planted individual trees or groups of trees, can visually screen eyesores and undesirable landscape features. In addition, properly placed trees can reduce or eliminate glare or reflected light from such sources as street lights, automobile headlights and reflective materials such as building surfaces, glass and water. Glare can often cause viewer discomfort or create visual hazards (McPherson 1988).

Not to be overlooked is the use of trees to provide privacy screens between neighboring properties. Unlike a solid barrier, such as a fence or wall, trees and other vegetation create a more permeable screen which provides privacy on a more sophisticated scale.

Erosion Control

Converting forest land to urban uses will produce changes: water yield and storm runoff will increase along with sedimentation from construction sites and lots devoid of vegetation. Forest areas within urban areas may be useful in disposing of and renovating waste water, recharging groundwater and stabilizing the soil (Lull 1970). Currently, 0.08 in. is used as the accepted estimate of rainfall interception potential for closed canopy broadleaf trees (Rowntree 1986). Using this estimate, researchers conducted a study in Salt Lake City and concluded that 17% (11.4 million gallons) of a one inch rainfall in 12 hours was intercepted and temporarily held by tree canopies. This water evaporated back into the atmosphere rather than draining from the site as runoff (McPherson 1988).

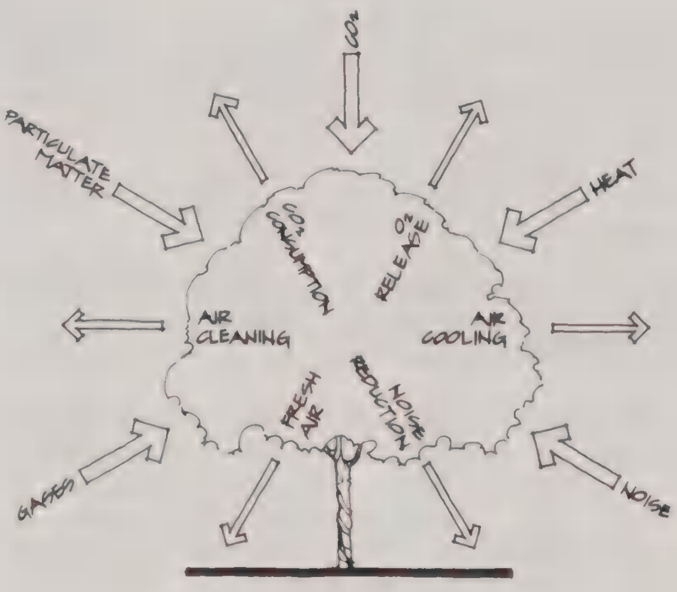


Figure 3-9. Tree Functions

Wind and water erode exposed soil. The effect of summer duststorms can be ameliorated by buffers of trees which disrupt windflow and allow suspended particles to settle. Water erosion is more common and potentially more damaging. Trees can protect soil from the degrading effects of water erosion in four ways: 1) they intercept and reduce the velocity of rainfall, 2) trees produce an extensive root network which prevents surface soil from being easily broken up and dispersed, 3) in addition, deeper roots bind topsoil to the layers of soil beneath it and finally, 4) leaves and other deposited organic matter decay and mix with the top layer of soil to form a protective mulch which resists disturbance by wind and water.

Some communities, such as State College, Pennsylvania, use urban wastewater to irrigate forest lands rather than spend additional funds to upgrade municipal treatment facilities to handle the increased effluent load. Secondary treated water sprinkled on public lands not only enhances tree growth but also replenishes heavily used groundwater supplies (Miller 1988). The forest acts as a natural filtering system for urban water supplies.

Traffic Control

Another function trees may serve in an urban landscape, particularly in parks and other heavily used public spaces, is to regulate traffic. By using plantings to block direct visual access, one can prevent pedestrians cutting across areas without regard for existing walkways (Miller 1988). This helps protect sensitive vegetated areas from extensive traffic which can damage plantings and grassed areas. Such damage can lead to increased erosion and the formation of unsightly patches on the landscape.

Trees are also used in median strips to separate oncoming lanes of traffic. They help to reduce the incidence of temporary night blindness caused by the glare of approaching vehicle headlights. Trees might also be used to direct traffic in such areas as parking lots, by delineating exits and entrances. However, trees used for such a purpose often suffer damage from automobiles and their careless owners.

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IV. ESTABLISHING AND NURTURING A PROGRAM

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ESTABLISHING AND NURTURING A PROGRAM

The benefits of urban or community forestry programs are well known, yet functional, effective programs are lacking in most communities of the Interior Western states. In many cases, this can be attributed to a lack of interest, or more accurately, a lack of **someone** with the interest and persistence to establish or improve a program. In this manual, we try to give that **someone** the information needed to justify a program. We provide in this chapter additional information to help that **someone** start the program, and tend its needs, so that like the trees for which the program will care, it will mature to provide maximum benefit to the community.

Starting a Program

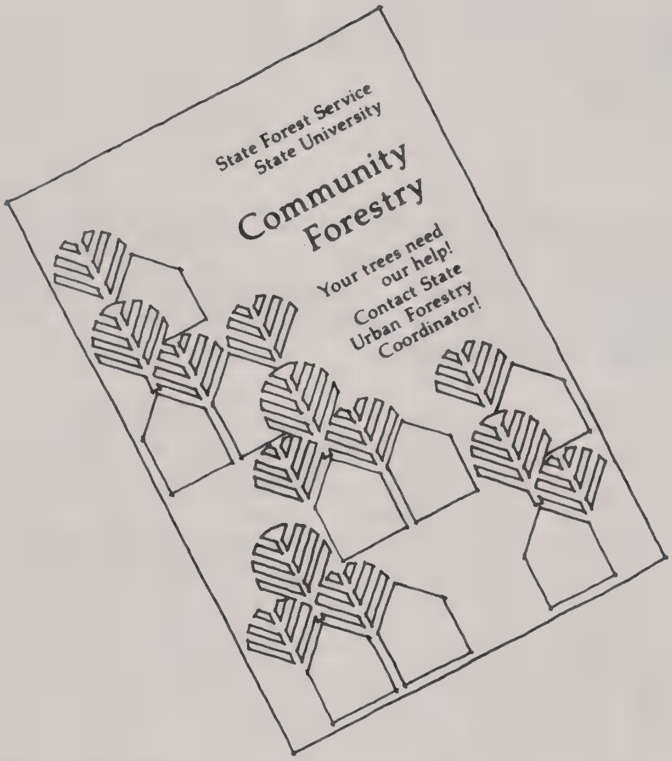
Programs get their start in many ways. Often, a citizen becomes involved to protect trees from some crisis, be it utility trimming, street widening, or a life threatening pest. In other cases, that **someone** sees an opportunity to improve the quality of life by promoting tree planting and care. Escalating insurance rates may also stimulate the establishment of an urban forestry program. Typically, someone (usually a municipal employee) is approached by an agent of the city's insurance company and is told that insurance is not available, or that insurance will cost a great deal more in the future due to higher risks. When the risks are examined, tree care emerges as one area where risk can be greatly reduced for a relatively small investment.

The first task in starting a program, then, is to find and identify the interested **someone**. That person need not be a professional tree care worker: he or she need only have an enthusiastic compassion for and conviction about the value of trees. This person could be you! Once this person or group becomes committed, the seed is planted for generating citizen support for the program. This person can then assemble others who are interested in trees. Citizen support is essential. To borrow the title of a presentation by Bansley, (1986) "citizens are the roots of a healthy tree program." Citizen groups are powerful and helpful tools. A good place to recruit group members is from local garden clubs, environmental groups, and other citizen/service groups such as Lion's Club, Rotary Clubs, etc. Representatives from local nurseries, tree care firms, and the local state and federal forestry agencies can also be helpful. A community leader who is influential, progressive, and respected can make an important contribution to the group by leaning on other influential people to win their support for the program. Once the ball gets rolling, this leader can then leave the organizational details to the group (Bansley 1986).

This support can "snowball" and make the idea of an urban forestry program into a reality. Someone from the city staff – perhaps someone from the city planning office, the parks and recreation department, or the city street department should be included. Perhaps a member of the city council, or at least a representative of that group should be involved. Although city council members are often very busy, cultivating a member's interest and support early will pay great dividends. If a council member is not available, make some provision for informing the Council about the group's progress. A self appointed tree group that proposes an unsolicited program will have a very poor chance of success, regardless of the merit of its proposals, without support from the community's council or governing board.

Many of these suggestions are relevant even though the group may only be considering the absolute minimum urban forestry program – an annual hazardous tree inspection **and** correction. The group of tree people should include representatives from the city's street department, the local utility – be it a municipal or private company – as well as the individual charged with implementing the program. An interested private citizen should also be involved. This person has a different viewpoint and may be able to help avoid confrontations with the public. Someone from the local utility can often help both the city and the utility save money by cooperating to remove hazardous trees interfering with utilities. The utility crews can also report hazardous conditions they observe during their work. This communication and cooperation can become invaluable when the program expands, especially when either buys specialty tree care equipment and shares its use. Consider inviting someone from a local tree care firm to participate in the group. Their expertise and knowledge can help to design an effective low-cost hazard tree program.

Each state has an Urban Forestry Coordinator who can provide information and contacts from other nearby communities with community forestry programs. This individual is often an excellent resource for newsletters, meetings, workshops, and other learning opportunities.



One source of information worthy of special mention is the National Urban Forestry Forum, available free from the American Forestry Association (See Appendix A). The Urban Forestry Coordinator may be able to meet with the group, encourage them, and suggest ways to make the group more successful. The Urban Forestry Coordinator also administers pass-through funds which are often available to help communities establish programs in community forestry.

Work with group members one on one. Get them enthused about an urban forestry program. Then, bring the group together and discuss ideas about trees. Often, the state forestry department has field level resource persons who can work with the group. People from communities with established programs may be able to help. Be cautious, however. Do not try to copy even a successful program. Many factors make a program successful. Use many ideas to develop a program tailored to existing constraints and capitalize on the opportunities within your community.

Assembling the Shade Tree Commission

This group could become the nucleus of the shade tree commission. One early focus of the group should be to cultivate and demonstrate citizen support for a community forestry program. This may best be done through resident surveys. A simple survey printed on the back of a utility bill, as done in Logan, Utah, disclosed that most residents would support an urban forestry program. A similar survey in Wellsville, Utah, showed that 59% of the respondents wanted more trees, and 74% were willing to spend $1.00 per capita to improve community beautification. Such a survey can often be conducted at very low cost, and with an extremely high return rate. Also, consider opportunities to improve the community urban forest. Be positive. A group charging mismanagement in the past can alienate people and hamper its own success. Consider project costs and potential funding sources to cover those costs. These plans need not yet be firm, but the group should have some ideas about sources of funds because this issue will soon be raised.

Gaining Formal Recognition

At some point the group must make a presentation to gain formal recognition from the local government. Usually, this is a request to the Mayor and/or Council to formally recognize a shade tree commission, and charge it with some duty — perhaps to investigate the need for and feasibility of hiring a full-time or part-time tree manager, arborist, or urban forester, to develop a plan for tree care, or to draft a tree care ordinance.

After the group receives its formal charge and a shade tree commission is established, most programs begin a flurry of planning and other activity. If needed, the shade tree commission begins work on an ordinance. The planning process begins, and perhaps a tree inventory is started. In this flurry of activity groups often overlook two activities which are perhaps even more essential to the long term success of the program than ordinances, inventories, and planning. They may fail to consider public relations and program funding. The wise shade tree commission will devote substantial effort to these two areas from its inception. These topics are discussed later in this section.

The Shade Tree Commission should inventory the administrative resources available and the present level of tree care activity. Items which are included in this inventory include tree, landscape or other ordinances related to trees, tree care equipment such as lift trucks, pruning items, and planting machinery. Current crew, contract and budget levels are important also. This information will be useful as they go about planning and implementing the program.

Nothing has been stated about program structure. Many preach that one way is better than another; however, the best program structure is the one that works in that particular community. What works in one community may fail miserably

in another. The location of the forestry program in the community organizational chart is less important if responsibility for trees is consolidated in the community forestry program. Many community forestry programs are located in parks departments. This is usually a friendly environment because parks people deal with and maintain plants. Successful programs may also be found under the jurisdiction of power and street departments. In such situations, there may often be an adversarial position toward trees because these departments interact with trees only when they "interfere" with the services provided. These departments, however, are often well funded when compared with parks departments. Regardless of where the community forestry program is supervised, it will survive best by striving for cooperation with other departments.

Earning Tree City USA

As communities go about their efforts to improve the urban forest, they often seek and receive recognition. Everyone can name a program that is known to be a "good" program. What is a "good" program? Many communities consider their programs successful if they qualify for a Tree City USA award. The Tree City USA program, administered by the National Arbor Day Foundation, recognizes communities that have:

1. a tree board or department

2. a community tree ordinance

3. a community forestry program with an annual budget of at least $2 per capita

4. an arbor day observance and proclamation Thus, this award, a sign and a flag, is earned by those communities with a visible, funded program that involves citizen input and protects trees.

Figure 4-1. Well Done! Your City Cares About Trees

Earning the Tree City USA award is an excellent goal for a developing program. Membership of the person in charge of tree care, and perhaps the shade tree commission members, in professional societies, such as International Society of Arboriculture, or in the National Arbor Day Foundation, will reveal other awards and program recognition. But what about after these awards are achieved? In many communities, the program maintains itself at that level and then declines after a few years. Why the decline? Complacency? Perhaps, there is merit to the saying "the absence of growth is death." Many programs simply stop growing and eventually decay. But there is life after initial success. Programs in some communities survive and even thrive for some years. The remaining portion of this chapter is concerned with the characteristics of good programs and provides suggestions for future growth.

Urban Forestry – The Ultimate Goal

In discussion of the goals of an urban forestry program, one hears such things as "planting as many trees as are removed," a community arboretum, endowed funding for the tree planting program, or increasing species diversity in the street tree population. Too often, according to one urban forester, "communities are stuck on tree maintenance rather than a total tree program." One can argue that the community forestry program must include an essential element besides trees: people. One goal of an urban forestry program should be that of changing public attitudes. With a change in attitude, all of the material goals are easily accomplished. This goal is difficult to state in words, but perhaps it is best encapsulated by the Amish belief that "We did not inherit the land from our fathers, we are borrowing it from our children."

But what is a really good program? There are many answers to this question, all of which may contain valid points. Hanson *et. al.* (1987) lists 12 indicators of effective tree care programs, based on a survey of and personal contacts with State Foresters and others involved in community forestry. These 12 points are listed in the Introduction and repeated here for emphasis. They should be kept firmly in mind to provide a focal point for the developing program.

Indicators of effective tree care programs.

1. Tree care agency or at least a person responsible for tree care.

2. An identified budget derived from several sources. (While only $2 per capita is required for Tree City USA recognition, the national average expenditure per tree is $2.60 (Kielbaso 1988).

3. A well-managed and maintained publicly owned tree resource.

4. Trained tree workers and arborists in public and private tree care.

5. A workable tree ordinance or regulations and guidelines.

6. Annual work plans for public tree care.

7. Developing or working under a master plan that involves all major city infrastructure.

8. Initial and continuing participation in new developments and growth areas.

9. Inventories or assessments of the tree resource.

10. Education and outreach to citizens, school children, teachers, and political and city leaders.

11. Citizen and leader participation in planning and implementing tree care programs and events.

12. Media involvement and coverage of forest conditions, tree care activity, and citizen involvement and recognition.

Programs that meet these 12 criteria will continue to grow and be effective. As stated by an urban forester in Colorado, "We currently are reactive to most tree concerns, rather than proactive. We need to establish a systematic program to assess hazards . . . We currently provide only insect control, hit and miss pruning, and tree planting and removal." There is much more than tree management in an urban forestry program: there are people involved. Only when the public is involved will a program have the support to become proactive rather than reactive.

Planning

Becoming proactive requires planning, yet few communities plan effectively. A plan is a map. If the community does not have the vehicle to reach its destination or goal, a quality map or plan is of little use. A good plan should be accomplishable, within the abilities and limitations of the community forestry program. The plan must be written down. Perceptions change over time. People forget. A plan can serve to document the intent of the program. Long term goals should be broken into smaller annual, or even quarterly objectives or tasks. Unlike driving the highway, there are no signs that say "Destination 121 miles" along the community's route. Why not make your own so that you can measure progress? Along with each task or subtask, indicate a realistic date of completion, and record it in the plan. If you really want to get things done, indicate who is responsible for each task. Identifying "who will do what by when" allows progress to be monitored. (See example following.) Lack of progress can be corrected or the plan changed. An alternative way to plan is to maintain a large, annual "write-on calendar" and note a starting and completion date for each task. Daily, cross off those tasks completed, and circle in red those which are overdue. This can provide those working on tree care a quick view of where they are and where they need to go in the immediate future. Thorough planning is essential to channel energy and funding into an effective community forestry program. To quote an old saying, "speed is no advantage when you're going in the wrong direction!"

Below is a sample of an annual work plan for part of a community forestry program. Each item **(what)** identifies **who** is responsible and **when** they will complete their task. Estimated expenses to do these tasks should also be included.

Annual Dutch Elm Disease Survey Plan

<u>Goals</u>

All hazard trees will be removed.
All diseased elms will be removed within 28 days.
All woodpiles will be examined for elm wood by 1 April.

<u>Objectives</u>

Newspaper article prepared by 15 January notifying public of upcoming woodpile inspections and encouraging them to burn elm now.
Community forester begins woodpile inspections 1 February and makes sure all elm wood will be disposed of by 1 April.
Community Forester will contract for tree removal by March 31.
Community Forester will contract for and train tree inspectors in May.
Community forester publishes article in local newspaper informing residents about community's effort to combat Dutch elm disease, what to look for, and how to report a suspect tree by June 1.
Tree inspectors inspect areas beginning June 15 and at 2 week intervals until fall color develops, providing written notice to homeowners. Disease trees on private property are checked after 2 weeks for compliance.
Community forester is notified of diseased city trees the morning after detection.
Community forester notifies contractor of tree removals weekly, verifies their removal weekly, and authorizes payment of contractor monthly.

Community publishes article in local newspaper summarizing disease progress and thanking citizens for their support by September 30.

Figure 4-2. Salt Lake City Mayor, Palmer Depaulis and Grand Prize Winner, Jared Felt, Age 12

Figure 4-3. Jared Felt's GRAND AWARD Poster, Utah 1st Annual Arbor Day Poster Contest, 1988

Generating Public Support

Establishing positive relations with the public is one of the most important ways of generating support for the community forestry program, yet most people are poorly prepared to serve this essential role. Many active in urban forestry want to be left alone to "do their job," without having to spend time communicating with the public. This attitude restricts the use of one of the most effective urban forestry tools available: public support. The public may not agree with every management action, perhaps rightfully so, but without general support of the public, the community forestry program is doomed.

So how does the shy person in charge of tree care go about meeting the public? The first contact to make is with the editor of the local newspaper. Local newspapers are always trying to serve the community and are searching for local news. The editor may work with you, or you may be assigned to work with the garden reporter or the community government reporter. Let these people know what you do, and offer to help in any way. If you are a good writer, they may ask for a brief monthly article from you. If they don't, offer to write a weekly or bi-weekly column on the tree program and tree care. They may just wish to talk with you and write the story themselves. Do not be offended! They are professionals — let them do their job. Your role is to provide them with accurate information about the program and technical information about the trees.

Always remember to be positive. Public criticism will polarize people. **Advertise** the community forestry program. The community forestry program is one program that brings positive benefits to homeowners for a relatively small cost. Remind them of this. **Advertise** a phone number where you can be reached. If you cannot keep regular office hours and do not have a secretary to answer the phone, use an answering machine to record messages. Return calls promptly. Seeking public contacts may increase the workload, but provides great returns. During times of budget stress, a vocal public used to receiving quality service from the city can be of great help in preserving the program. Offer to meet with newspaper reporters on a regular basis. Take them to project sites. Invite them to shade tree commission meetings. They must know what the program does and how it works, so they can correctly convey this information to the public. Ask them for ideas on how to get the message to more people. The more visible the community forestry program (and you!), the more successful it will be. Always be available for the media. If you do not culture the media as advocates of the

community forestry program, they can become very formidable adversaries.

If your community has a local radio station, make that your second stop. Local stations are always looking for local information. Radio stations, particularly those in smaller communities, are often eager to do public service. They can be of tremendous help in publicizing issues and projects. Work with them as you would the local newspaper. The more awareness people have of the community forestry program and its goals and activities, the easier these tasks will be to accomplish. Consider a weekly tree talk show. Even 5 minutes to summarize accomplishments and remind the public of tree care needs will be beneficial. If the urban forester is not comfortable "on the air," consider using an informed member of the shade tree commission.

The media can make citizens aware of the program. Their support becomes even stronger when they are involved in it. Start young! Arbor day activities should involve children! After all, Arbor Day was started to pass on the values of planting trees. Involve the children, and their parents become involved. A statewide Arbor Day Poster Contest and Planting is a great way to involve thousands of school children and supportive parents. Utah involved 30,000 children in its first contest.

"Tree Planting Day" thay called it
In Nebraska long ago.
Now we call it Arbor Day, and
Oh, I love it so.
I love to plant a growing thing --
A tree, a shrub, a vine --
And know it will for years and years
Keep growing there, a sign
To children who come after me
That someone thought of them,
And left behind a living friend
More precious than a gem.

--Betty Foust Smith

The National Arbor Day Foundation provides many other examples of successful Arbor Day programs (Figure 4-4).

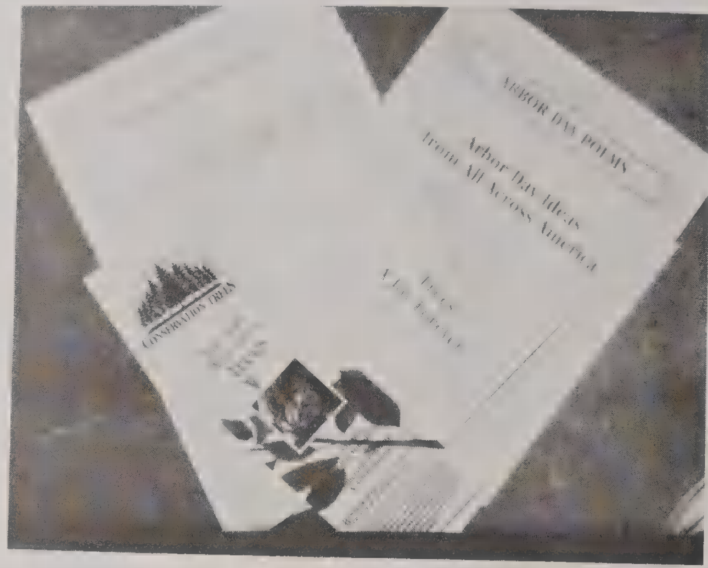


Figure 4-4. The National Arbor Day Foundation is a rich source of ideas for Arbor Day programs. These ideas, a few trees and some children are a sure-fire recipe for success

Take advantage of every opportunity such as the opening of a new building, park, or store, the graduation of the local high school class, or the death of a community figure to plant commemorative trees. Consider starting a memorial forest in a park or elsewhere, for planting memorial trees for loved ones. Or what about a children's forest, where parents may plant a tree at the birth of a child? All of these occasions offer opportunities to involve citizens and generate support for their urban forest.

Communities have used many other means to increase their visibility in the community. Austin, Texas, and Logan, Utah, and certainly other communities, recycle Christmas trees. The wood chips and landfill savings derived from such projects are minimal, but they do instill in the community the idea that we need to and can become more environmentally responsible. Reno, Nevada, sponsors Adopt-A-Park, an annual spring clean-up of city parks by volunteers, and accepts trees as donations for any good excuse. Sante Fe, Albuquerque and Socorro, New Mexico finance boulevard tree plantings with a Adopt-a-Median Strip Program. Donors are credited with name and identification signs in the median strip. Salem, Oregon sends a newsletter to each household along with the water and sewer bills to keep the community informed. Bumper stickers and T-shirts also promote community awareness, and can be sold to raise funds. Regardless of the means, it is important to get the message to citizens that the community forestry program — their program — is a benefit to them and is responsive to community needs.

This discourse on public relations would not be complete without discussing public relations in the day-to-day operation of the program. People involved in the program work with – and **FOR** – citizens of the community every day. They should be dressed as professionals, and should be easily recognized as community forestry staff. Consider outfitting the staff in shirts printed with the community logo, the title of the appropriate department, and, where possible, their names. The extra expense will greatly improve public reaction to the employee and develop employee pride. Consider blaze orange shirts – they contribute to employee safety.

When meeting the public, community forestry workers, from employees to tree board members, should always be courteous and respectful. These people represent the community forestry program to residents and others. Within every community there is at least one unsupportive person who will challenge the patience of workers. Even though the worker may be correct, a shouting match has no winners. Acting in a professional manner is the only viable option in such situations.

The community forestry program must develop a protocol for communicating with homeowners who are not home during the day. Letters may be written after returning to the office, but then they must be typed, signed and mailed, requiring several days to get the message across. A more timely and economical solution is to have an attractive door hanger printed with brief information about the purpose of the visit, e.g. tree trimming or disease survey. Leave space for the worker to write in his or her name, a short message, and a phone number for the homeowner to call with questions. Such information placed on the door will help the homeowner to understand and respond to the situation. Door hangers may also help to alleviate the curiosity and concern of neighbors.

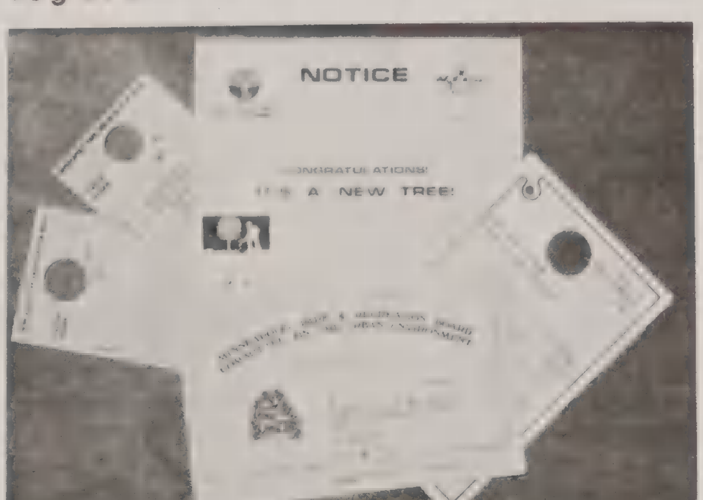


Figure 4-5. Examples of door hangers and other printed materials to inform homeowners about community forestry projects

Regardless of how the program is promoted, the public will have an opinion of its worth. The community forestry program is providing a valuable service to the community, **one which many citizens may not be informed about**. Increasing their awareness is essential to the perception of an effective program, and is necessary for program survival, particularly in times of budget constraint. If they don't get this message from the program, what thoughts will they have?

Funding the Program

Many programs begin with great enthusiasm but never reach their potential because they lack funding. Lack of program dollars is probably the greatest constraint to community forestry programs. Smaller communities, even though their needs are less, often feel the most constrained because of their small tax base.

There are no magic formulas for funding a community forestry program. Each community has different needs and potential opportunities. Some options to consider are in Appendix I. Some may have already been tried; others may be inappropriate. With good public relations, an open mind, persistence, and a bit of luck, community forestry program leaders can find a means to accomplish almost any project. Explore as many alternatives as you can, and keep watch for new sources of funding. Don't be afraid to ask for support: assistance – financial or other – is rarely offered without a request. Involve influential members of the community in seeking support. If solicitors have "the right connections," many contributors will find it difficult to say no. Use any evidence you have of citizen support for the proposed project or program. Contributors will want to see that they are supporting a cause that citizens consider worthy.

Nurturing the Program

Let us suppose the program has reached the level where the public is aware of the program, the program is funded, the ordinance, inventory and community forest plan are in place and progress is being made. What next? There are still ways for this program to grow: increased public involvement and increased professional involvement. How are interactions with the utility company? How are arborists trained?

A thriving community forestry program always looks for ways to involve the public. DeVoto (1986) discusses the advantages of involving the public in the follow-up care of newly planted trees. Why not? With the right information, individual homeowners can care for their trees and ensure

Figure 4-6. Planting for Tomorrow

their survival. The Adopt-A-Tree program has been instrumental in helping the city of Minneapolis meet its tree watering needs. Continued public involvement through Arbor Day celebrations, tree plantings in conjunction with major community events, and fundraising activities can help to keep the program rolling.

The community forestry program must also reach out to those who care for trees in the community, including private contractors and utility companies. Improving the relationship with other tree care professionals will go a long way toward improving the community's overall tree care. Work with these professionals. A plan for working with utilities should include training them in pruning techniques that will reduce the need to prune trees under the wires. Working with them to identify trees interfering with utilities that should be removed is a major benefit to both parties. Often, the utility will remove the tree for the community, saving the community the cost of removal, and saving the utility the cost of repeated future prunings. Conflicts between trees and utilities can be reduced by providing the utility company with handouts and other materials which show homeowners the proper way to trim trees and the proper trees to plant near utilities.

As a community forestry program is recognized and continues to improve, other communities recognize the quality of the program, and seek advice. Allow time for "networking." Even though the program is good, the program can still benefit by seeking input from others. Reading National and state newsletters keeps the Forester abreast of "who is who" and "who is doing what" in the network.

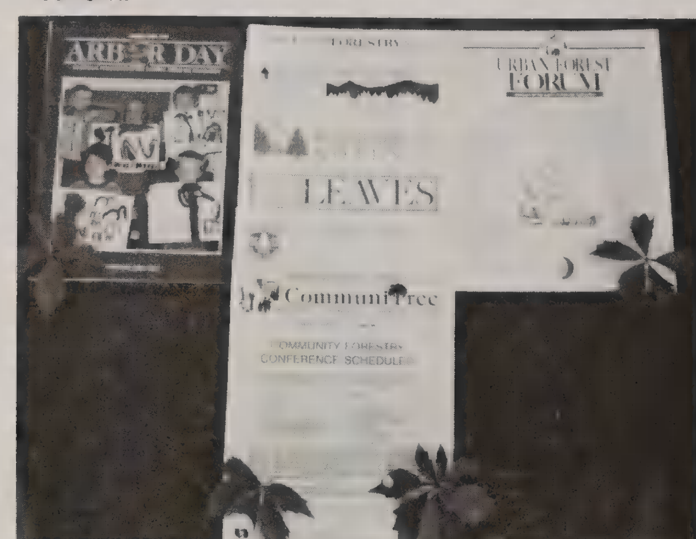


Figure 4-7. Keep Current by Reading Available Newsletters

The urban forester, or person in charge of tree care, and perhaps even members of the shade tree commission, should **at the minimum,** be members of a suitable professional society and be permitted to attend professional society meetings. Societies that function in community forestry include the International Society of Arboriculture, the American Forestry Association, National Arborists Association (Addresses for these societies are in Appendix A). Funds to attend state, regional and national meetings should be budgeted. Funds may also be obtained from the State Forester, from private foundations, or from corporations. People responsible for the program need to continue their learning, and, perhaps of equal importance, they have a responsibility to return some of what they have learned to the profession. This "mentoring" can help other communities to have effective programs, and thereby improve community forests throughout the region.

Another form of contributing to the profession is in offering and requiring training for private and utility tree care professionals. If you are going to offer training for the city's tree care workers, why not invite workers from private firms and utilities? If your community chooses to send workers to tree care workshops in other communities, invite other tree care professionals to ride with community workers and attend the training sessions. The relationships developed will benefit the community at large as well as those directly involved. Having better trained crews means better tree care throughout the community.

This chapter has suggested many ways to develop and improve a community forestry program. Some will work in your community, some will not. Do not hesitate to use ideas not mentioned here that may be more applicable to your community. This chapter is not a "roadmap" to success. We have attempted to provide ideas to help the program grow and survive. Citizens will continue to plant trees. To quote Willeke (1986, p 19) "This is our categorical imperative, and thus it should be our maxim that we shall build a forest, not a forest away and apart from the bulk of humankind, but a great forest encompassing nearly the whole of our human habitation. Let us then, in the words of Immanuel Kant, act on that maxim which we can at the same time properly and rightly will to be a universal law." Organized under the auspices of a community forestry program, trees can be selected, established and cared for so that they will have a long and useful life.

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V. INVENTORIES

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INVENTORIES

Two basic types of inventories are essential prerequisites to preparing a community forest plan. The first is called a Community Pattern Inventory. Such an inventory insures that all potential design opportunities and constraints in the community (landscape features, land uses, and streets) are identified and recorded on the Community Pattern Composite Map. Once inventoried they can be evaluated later as the Community Forest Plan is developed. The second inventory, a Tree Inventory, provides useful information on the extent and condition of the community forest. The depth and breadth of the Tree Inventory will vary, depending on the size and financial resources of each community. Together, these two types of inventories provide the information needed to develop a Community Forest Plan Map and Report.

Community Pattern Inventory

Undertaking a Community Pattern Inventory is a new idea in community forestry; traditionally communities have only conducted vegetation inventories. A Community Forest Plan concerns the visual character of the surrounding landscape as well as existing vegetation. The design arrangement and selection of trees depends not only upon the ability of the trees to grow normally at a given site but also upon their ability to complement and enhance the site. For these reasons the Community Pattern Inventory plays an initial and important role in the process that culminates in the Community Forest Plan.

The first step of the Community Pattern Inventory is to obtain at least five reproductions of a base map of the city. The planning or engineering departments of most cities have access to base maps and can make copies. If no base map exists, one can be made by enlarging the U.S. Geological Survey's Quadrangle Map for your area. It does not have to be exact for the purpose at hand.

Elements of the community pattern will be examined and noted on three separate maps. A final Community Pattern Composite will incorporate all these elements onto one map. The items inventoried on each map are identified below:

Map #1 — **Significant Landscape Features**
1. Special Places and Spaces
2. Existing Tree Masses and Distinctive Trees/Groves
3. Significant Topographical Features
4. Desirable and Undesirable Views
5. Significant Wildlife Habitat

Map #2 — **Land Use**
1. Commercial
2. Residential
3. Institutional
4. Industrial
5. Recreational
6. Open Space

Map #3 — **Streets**
1. Major and Minor Streets
2. Street Patterns
3. Utility Lines
4. Planting Strip Width

Map #4 — **Community Pattern Composite**
1. Significant Landscape Features
2. Land Use
3. Streets

In small communities, this information can be readily drawn on base maps of the town. Some of the information can be collected or field checked during the Tree Inventory. For larger communities with planning staffs, much of this information will already be mapped and the information can be simply transcribed onto a new base map. It may seem at the outset that there is enormous amount of information to record, but in fact doing a Community Pattern Inventory is a relatively straight forward and simple task. Most work can be completed during one or two working sessions. A detailed description of what each map includes and how it is drawn follows.

Landscape Character

Before the individual elements of the Community Pattern Inventory are discussed and mapped, the Shade Tree Commission should define the unique character of the surrounding landscape. These qualities should be written down and later used as a reference when preparing the Community Forest Plan Map.

Landscape character is important in making determinations about the type of planting pattern and species selection most appropriate for a community. Each community exists in a unique landscape, and that uniqueness should be reflected in the Community Pattern Composite. For example, a Community Pattern Composite Map for Bend, Oregon, located in a forested setting high in the Rocky Mountains, would reflect the surrounding character of mountains and forest. A Pattern Composite Map of Park City, Utah would be totally different than one for Huron, South

Dakota, a small community which spreads out across the flat, treeless agricultural landscape of the Great Plains. Each landscape setting is unique and should be treated as such when preparing the forest plan.

After the Shade Tree Commission has identified and recorded the unique qualities of the surrounding landscape, four base maps will be needed. Label them: (1) Significant Landscape Features, (2) Land Use, (3) Streets, and (4) Community Pattern Composite. The working group can then be divided into three teams, each team being responsible for one of the first three maps. Each team will need several colored pencils or magic markers and pens and pencils. It is best if the groups are in the same room and close to each other so that there is a free and easy interchange between the teams as they work.

Significant Landscape Features

The character or personality of a community is primarily the product of its significant landscape features. These features contribute in numerous ways to the overall community pattern and are therefore important elements that should be located and mapped. Draw the location of the following landscape elements onto the base map labeled Significant Landscape Features.

Special places and spaces. It is important to identify spaces and places that are unique to the community. These include high use public places such as parks, playgrounds, town squares, schools, cemeteries, commercial areas, churches, monuments and other landmarks. Studies done by Utah State University's Department of Landscape Architecture indicate that these unique places often hold special meaning for local residents. Surveys during informal public meetings or simply observation may be used to poll the local citizens and determine what and where these special places are. Because they contribute to the total image of the community, the Commission should note these features on the base map and single them out for special planting attention.

Existing tree masses and distinctive trees. In most communities the existing street trees will be a major component of the overall visual pattern. The easiest and best way to map the existing forest is from an aerial photograph of the community. Most large cities have aerial photographs that can be used. Smaller cities may obtain them from the local Soil Conservation Service office or the U.S. Geological Survey (Appendix A). In very small communities the Shade Tree Commission members may be able to identify the location of most existing tree masses without aerial photographs, though photographs are inexpensive and useful. All that needs to be recorded on the base map is the approximate location of the tree masses and the species that comprise them. In any case, field checks may be necessary. This checking can be done at the same time the Tree Inventory is being conducted.

Distinctive trees are identified and mapped because of their prominence and visibility in the landscape. These trees are usually large, historic specimens that are excellent examples of their species. Groves of distinctive trees may exist in the community. Their locations should be noted on the base map and every effort made to preserve and enhance these living landmarks. Distinctive trees and tree groves should be identified by the Commission and their value as a community asset publicized.

Significant topographical features. Many communities in the region-particularly those near mountains, rivers, streams or in areas with diverse topography-will have highly visible natural features which bisect the pattern of streets. The riparian vegetation which flanks the James River as it flows through Jamestown, North Dakota, for example, provides a dramatic and welcome contrast to the grid pattern of Jamestown streets. Such wooded corridors are a tremendous natural resource for any community that has them. They have excellent potential for a variety of recreation activities. In addition, they provide wildlife habitat and play an important role in the ecology of the adjacent landscape. In recognition of these values, Denver, Colorado, and Boise and Idaho Falls, Idaho, have initiated major reclamation and revitalization programs for their river-related forest resources.

Another similar element of considerable visual importance is the vegetation that grows adjacent to the irrigation canals running through many Interior Western communities. Although most of this vegetation grows within the easement controlled by the irrigation company, it may be useful to contact the irrigation company and discuss the possibility of a joint tree management program.

All stream corridor and canal systems, existing stands of natural vegetation, steep and unbuildable slopes, and significant patches and corridors of wildlife habitat should be recorded on the base map so that they may be considered for integration into the community forest plan.

Desirable and undesirable views. One of the unique aspects of many Interior Western communities is the landscape setting. In most cases communities either reside in or have views of spectacular mountain or mesa scenery, plains, or desert. The character of these landscapes forms an integral part of each community's personality. Whenever possible, the planting of the

community forest should accent the most desirable views. Most communities also have undesirable vistas of junkyards, landfills, storage areas, industrial facilities and large parking lots. Public plantings to screen these eyesores from residents' and travellers' view can enhance the attractiveness of a community. All important views, both desirable and undesirable, should be identified on the base map so that they can be incorporated into the Community Forest Plan Map. These may be field checked during the Tree Inventory.

To map these landscape features it is necessary to draw symbols that represent each element on the base map titled Significant Landscape Features. The following elements and corresponding symbols should appear at the same place on the map as they are found in the community.

Map #1 — Significant Landscape Features

Special places and spaces: Outline each place.

Existing tree masses and distinctive trees: Outline in black and infill with green all tree masses and distinctive trees and groves. Note the common name of distinctive trees.

Significant topographical features: Use a blue diagonal cross-hatching to represent canals, streams, and water bodies. Show steep slopes by cross-hatching in red.

Significant Wildlife Habitats: Outline in brown all areas identified as significant for wildlife. Label any species-specific wildlife habitat (Heron Rookery, for example).

Desirable and undesirable views: Show the direction of desirable views with a solid green arrow and undesirable views with a solid red arrow.

The Shade Tree Commission may elect to use different symbols than those described above. The important thing is that the map is accurate and easy to understand. An example of a Significant Landscape Features map is shown in Figure 5-1.

Land Use

The arrangement of land use affects community pattern. For example, the visual character of a residential neighborhood is significantly different than that of a business district, commercial strip or industrial complex. These differences are the result of variation in architectural form, building materials, space between buildings, setback distances and traffic patterns (pedestrian and motorized). Many of

Figure 5-1. Significant Landscape Features Map

these differences will affect both planting arrangement and species selection in the Forest Plan. Consequently, **land use patterns should be recorded on a base map so that these areas may be given careful consideration in the final planning process.**

Common descriptions of various land use classifications are listed below:

Commercial. Businesses and shopping centers.

Residential. Housing, often subdivided by type (single family, multi-family) or density (high, low).

Institutional. Churches, schools, governmental lands and buildings.

Industrial. Manufacturing, processing and production facilities, often subdivided into Light Industry (non-polluting) and Heavy Industry.

Recreational. Parks, playgrounds, sports facilities.

Open Space/Agricultural. Agricultural and vacant land within the city.

The Planning departments of most cities have land use maps which you can easily transcribe onto the base map. Notice that a different color or pattern is used to denote each land use classification. If a land use map does not exist, map first the various land use locations that you can accurately recall. Field check these locations and collect land use data at a later date or while taking the Tree Inventory. Colors commonly used for the Land Use Map are as follows:

Map #2 — Land Use
- **Commercial:** Red
- **Residential:** Yellow
- **Institutional:** Blue
- **Industrial:** Purple
- **Recreational:** Green
- **Open Space/Agricultural:** White

An example of a Land Use map is illustrated in Figure 5-2. Letters and other symbols are used in place of colors.

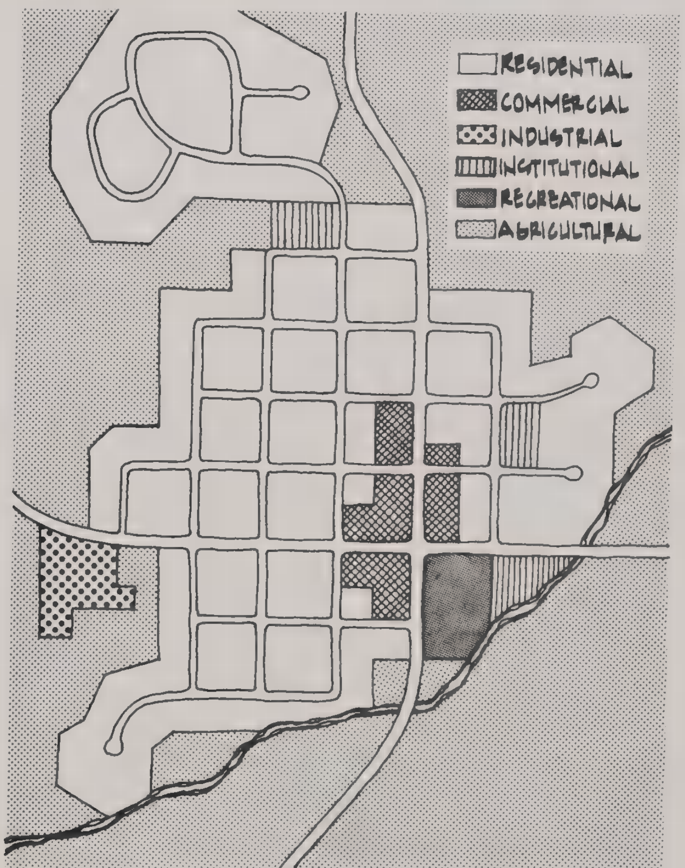

Figure 5-2. Land Use Map

Streets

The dominant pattern in most Interior Western communities has been formed by the street system. Because streets are the most frequently traveled routes, the views from them significantly influence community attractiveness and identity. In addition, the location of utility lines, adjacent buildings, and the configuration of the planting strip beside the streets can provide physical constraints to tree selection and location. For these reasons the Commission should be sure that the following street-related elements are recorded on the map:

Identification of major and minor streets. Major streets are streets that are most frequently traveled. Generally, these streets are the widest ones in the community and thus constitute important elements of the community pattern. Wide streets generally require large, wide spreading trees and bold planting compositions to visually unify the streetscape. The narrower minor streets can be unified by smaller street trees and either formal or informal planting compositions.

In large communities there may be three distinct street categories: major, minor and unimproved. The Shade Tree Commission should develop the categories most appropriate to its community, bearing in mind that frequency of use and street width are the two important factors.

Street patterns. In most Interior Western communities, the dominant pattern element is the street system, usually a grid of wide streets paralleled by irrigation ditches, a remnant of early land subdivision practices. However, as cities have grown in recent years, the grid has been modified or abandoned in favor of narrow streets and nonlinear patterns. Frequently new development is either spread out along major roads or clustered around special amenities at the edges of older development. Consequently, clusters of new development are often located at a considerable distance from older sections of the community. The total resultant pattern is one of a tight grid core which becomes less structured as one moves to the edges. Unifying this fragmented pattern is a major challenge in preparing a Community Forestry Plan Map.

Community pattern is clearly reflected in the street system evident on the town base map. It is helpful to note on the base map where significant pattern changes take place, where the pattern breaks down, and where tree planting could be useful in unifying dissimilar pattern elements.

Utility lines. Every year utility companies and municipalities spend enormous sums of money pruning trees to avoid conflicts with wires, or repairing wires that have been broken by damaged or unhealthy trees. A common and distressing sight are flat topped Green Ash trees pruned to 15-feet tall under power lines, with handsome 50-foot tall unpruned Ash trees directly across the street. The location of aboveground utility lines near potential planting strips will, in most cases, dictate the selection of tree species whose natural

size and form will not be limited because of overhead wires. Generally, phone lines and television cables are hung below power lines. Since these lines are not "live" they should be ignored when estimating the height of overhead wires. If the difference between "live" lines and phone lines is unclear, contact your local utility representative for clarification.

The only accurate way to map the location and height of overhead wires is in the field. In a small community this may be done quickly by driving the streets and having the passenger record the data on a base map. Perhaps the easiest way to collect this information is during the Tree Inventory, when the city will be canvassed anyway. After collecting this data, transcribe it onto the Streets Map.

The location of underground utility lines is less critical but still important. It is not desirable to plant street trees directly above underground utilities that are less than four feet below grade. Tree roots may damage improperly installed utility lines and hamper access to the lines.

The location and depth of underground utilities can be obtained from the city engineer or the local utility companies. Also, ask them if they know where future installations are expected. Note these places on the base map so that street trees are not planted until the lines are installed. Be aware, however, that future utility maintenance may damage trees.

Planting strip width. The size of the space next to the street (the planting strip) or in the tree lawn will influence the size and arrangement of street tree plantings. Narrow planting strips (those less than four-feet wide) are most limiting because only small, deep rooted trees should be planted there, if any at all. A larger tree will crack and raise the adjacent sidewalk and/or curb and gutter. Large amounts of money are spent annually repairing sidewalks damaged by ill-advised plantings of trees too large (or too shallow rooted) for the planting strip.

The wide planting strips that occur where no sidewalk exists, or where the existing sidewalk is set back 10 or more feet from the street, provide for more flexible planting arrangements than do narrower planting strips. For instance, group plantings of small flowering trees and very large trees will, when mature, provide an overhead canopy that helps to unify the streetscape.

It is also important to notice if there are any structures within 25 feet of the planting strip. In many small town commercial areas, the businesses are as close to the curb as 10 feet. Large, wide-spreading trees planted adjacent to the street in this situation will eventually branch into the structure especially if the building is two stories or taller. Most trees that thrive in the Interior Western region do not have a crown diameter that exceeds 50 feet. Therefore, if structures or obstructions are 25 feet or more from the planting strip, there will be no limitation to tree selection on the basis of ultimate crown diameter.

It is not necessary to record the dimensions of every planting strip. Most planting strips in every community will have a characteristic width, generally between 3 and 12 feet. If the width of the planting strip varies significantly from the norm, make a note of it. Planting strips that are very wide or less than 4-feet wide present unique opportunities and constraints. Indicate their presence and dimensions on the base map. Also note the setback distances of buildings within 25 feet of the planting strip.

As was the case with overhead wires, planting strip characteristics should be observed and recorded in the field. In a small community this can be done quickly by two people in a car. For larger communities this information can be recorded on the tally sheets during the Tree Inventory and later transcribed onto the Streets Map.

To graphically depict these elements on the Streets Map the following symbols are suggested.

Map #3 — Streets

Major and minor streets: Color major streets with a wide, dark line. Leave minor streets uncolored. If streets of intermediate importance are designated, color them gray.

Street patterns: If the predominant pattern is a grid, leave it uncolored and outline in gray the areas having an irregular pattern. Use a dark dashed line to mark transition points between different street patterns.

Utility lines: Use a narrow, solid black line to indicate where overhead wires exist. Note the height of the wire if it varies from typical (25'). A dashed black line is suggested for underground utilities.

Planting strip width: Use a red star to indicate areas where the planting strip is narrower than 4 feet. Also use a red star to denote areas where a building is within 25 feet of the planting strip. Use a green star at areas where the planting strip is wider than is typical. The dimensions of the planting strip width and set-back distance can be noted in or adjacent to the star.

An example of a Streets map using slightly different symbols than those suggested above is shown in Figure 5-3.

Figure 5-3. Streets Map

Community Pattern Composite

After the first few working sessions, the three Community Pattern maps should be nearly complete. In most cases, information of questionable accuracy and missing data will have to be verified and collected in the field. Most of the following information will likely have been entirely collected or field checked during the Tree Inventory:

Existing Tree Masses and Distinctive Trees
Desirable and Undesirable Views
Land Use
Overhead Wires
Planting Strip Characteristics
Building Set-Backs

After obtaining the above information from the Tree Inventory and after completing the maps just described, you are ready to draw the final Community Pattern Composite map. Before beginning the map, you should begin to consider how the factors mapped during the Community Pattern Inventory relate to planting design pattern and tree size at any given location. Read the section of this manual on the Community Forest Plan Map. Its message, simply stated, is that planting design pattern and tree size are the primary elements designated in the map and these in turn are directly influenced by community pattern. Community pattern is the context to which the plan must respond.

Drawing the Community Pattern Composite map allows the Commission to neatly and accurately render on one base map all the data that has been collected, transcribed, and revised on the three maps (Significant Landscape Features, Land Use, and Streets). Thus, this final map is a compilation onto one map of all the features previously mapped. The symbols used previously are used again in the same manner to represent the same features as before. The following suggestions may be useful in developing the Community Pattern Composite map.

Map #4 — Community Pattern Composite

Land use: The land use classifications can be transferred onto a clean base map entitled Community Pattern Composite by placing the original Land Use map under the clean base map and tracing onto it. Make sure that both maps are accurately aligned with each other. A light table, if available, will make the task easier. Another option is to tape the Land Use Map onto a window. Then tape the clean base map on top of it. The light shining through the Land Use map will delineate the different land use classifications.

If the Commission wishes to save time and the Land Use map is neat and well drawn it can be used as the Community Pattern Composite base map. In this case, change the title and then draw data from the other two maps on it. This saves time because the Land Use data does not need to be transcribed.

Significant landscape features: Place this map under the composite that now contains the land use data. Transcribe the symbols that denote (1) special places and spaces; (2) existing tree masses and distinctive trees; (3) significant topographical features; (4) desirable and undesirable views; and (5) significant habitat areas.

Streets: Place this map under the composite that now contains data on land use and significant landscape features. Copy the symbols used to denote (1) major and minor streets; (2) street patterns; (3) utility lines; (4) planting strip width; and (5) building set-backs.

A legend that identifies the symbol used for each feature should be added to the map. Figure 5-4 illustrates how a finished Community Pattern Composite map will look.

The final Community Pattern Inventory map will give the Shade Tree Commission an excellent understanding of the full spectrum of design opportunities and constraints within the city. It will familiarize them with the visual and spatial structure of the community. **The map will play a major role in developing the Community Forest Plan Map.**

Tree Inventories

With increasing emphasis on urban forestry programs, many communities have done or are doing tree inventories. Although some of these inventories are still in use, most are not, and some have never been useful, primarily because of problems associated with accessing, understanding and updating the data. Cities are conducting inventories to manage trees more efficiently; to schedule periodic maintenance and to reduce potential liability resulting from tree failure. To make intelligent management decisions requires current and accurate data. Identifying these data and considering options for collecting them insures that the urban forest management information serves its intended purpose and will be useful in the future. In this section, we discuss these options and raise questions which will help cities to develop an inventory that will be useful in improving their urban forestry program.

Why do an Inventory?

The goal or purpose of an inventory must be identified before it is conducted (Ziesemer 1978). You must clearly define which trees you are interested in and why you want information about them. Not until the 'why' has been clearly defined can you identify the specific information to collect for each tree.

There are numerous reasons why a tree inventory should be conducted (Tate 1985). The first is to determine the need for a tree management program. Are trees growing well with little need for pruning, removal or are few planting sites vacant? An inventory can help make this determination. If all trees are growing well and streets are well stocked, then a program may not be needed. Numerous mature trees with dead limbs, standing dead trees and/or treeless areas, indicate that a program is definitely needed. Data collected can also be used to predict the longevity of the urban forest, providing a basis for long term planning (Bartsch et al. 1985).

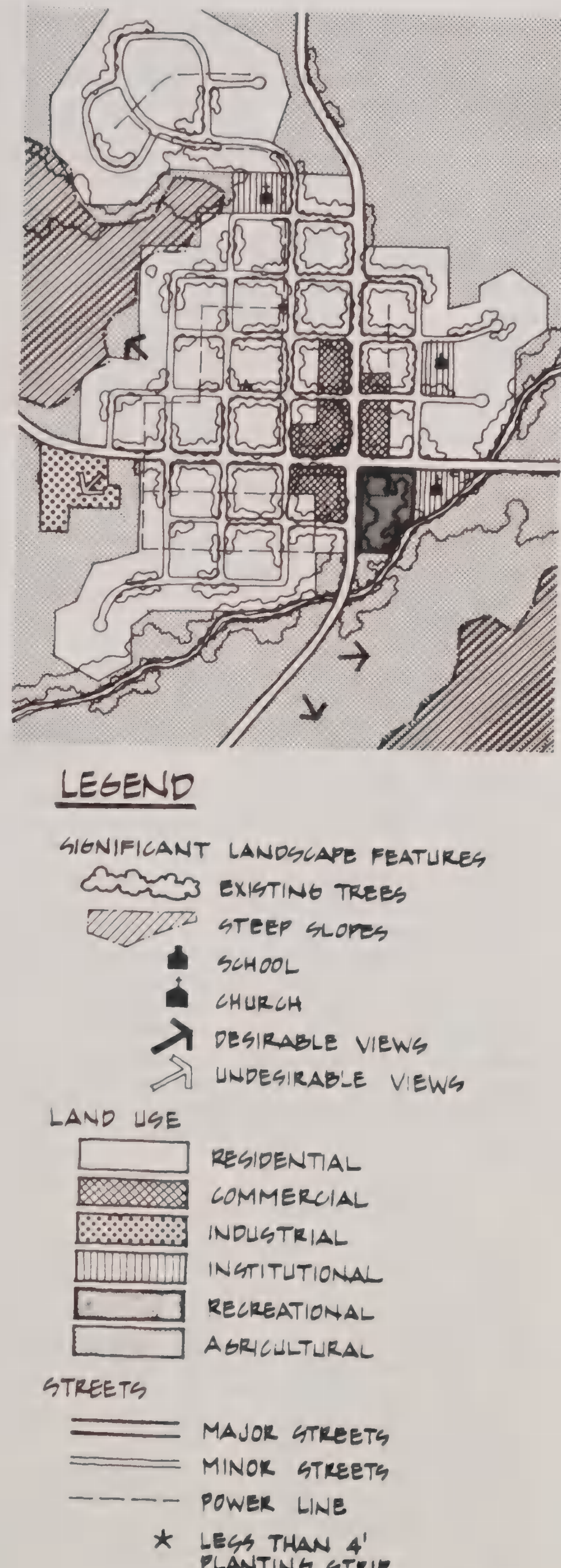

Figure 5-4. Community Pattern Composite Map

A record of tree values or total value of the tree resource provides a means of justifying the need for, or existence of, a tree management program. Realtors often tout the value of trees since trees often increase the value of residential property. Municipal decision makers can more easily evaluate urban forestry programs when they know the current investment in trees and the cost/benefits of proposed programs. Tree values can be determined for each tree or projected from a representative sample of trees.

An inventory can also serve as a basis for identifying and prioritizing work to be done: trees that need to be pruned or removed and sites for new plantings. With the total quantity of work determined, plans can be made to accomplish that work. Good inventory data make it possible to project budgets for routine tree maintenance work.

Increasing work efficiency is another major benefit of a tree inventory. Inventories that determine maintenance requirements of each tree make it possible to prioritize work. Hazardous trees may be identified so work can be efficiently scheduled and routed. If weather interferes with one type of work (e.g. large tree climbing/pruning) alternative work activities (e.g. small tree trimming) can be scheduled in nearby areas so crews do not waste time.

Inventories can also be useful in public information and education. Information on tree species, value, hazard potential, planting priority, canopy cover and density may all be extracted from an inventory and used to educate citizens as to the need for, and benefits from, well managed trees. This information can aid in planning for development. The tree inventory can also be reviewed to identify species which thrive in the locale. This information provides a basis for making planting recommendations and can be incorporated in a letter or brochure for distribution to interested citizens and local nurseries.

Even though these are good reasons for doing an inventory, to obtain the necessary resources, the person in charge of tree care would be well advised to show others how the inventory will benefit the City. More specifically, the Mayor, his staff and the City Council or Commission need to be informed as to how the proposed expenditure will allow the City to improve public service and how the proposed inventory will ultimately increase the efficiency of the dollars spent on urban forestry. Because better information can reduce tree hazards, reducing the City's liability, the city attorney is likely to support your request for funds and other resources. Street and utility departments also spend considerable time dealing with tree problems. Better information can help them do a better job.

Types of Inventories

Defining the objective of the inventory makes it possible to determine the type of inventory, i.e. how much data will be collected and how it will be updated for future use.

Specific Problem Inventories collect information about one problem or condition, information which can be used to prepare contracts or schedule work. These inventories collect minimal data and can be completed quickly and inexpensively. Hazardous tree surveys, Dutch elm disease inspections, stump inventories, and planting site inventories are common examples.

All cities should conduct an annual hazardous tree survey. These inventories collect the absolute minimum information that all cities should have. Typically, an observer in a vehicle (driven by another person for safety reasons) looks for potentially threatening conditions and records the problem and its address or location. Marking hazardous trees during the inventory is not recommended since doing so may increase liability problems.

Figure 5-5. All communities should conduct an annual survey of hazardous trees, and assess damage potential. Has your community conducted one?

Partial Inventories compile data from a sample or small portion of the city. Depending on the percentage of the tree population sampled, partial inventories can be completed rapidly and inexpensively while driving or walking. The observer doing a "windshield" survey records data from the vehicle, thus spending little time with each tree. The address is usually not recorded because other parameters are of primary interest. Ten percent of the tree population is typically examined in a windshield partial inventory.

On-ground inventories are most often used to prepare tree work contracts. During on-ground partial inventories, surveyors collect more data on each tree, usually including the address. If representative areas are sampled with either option, results can be statistically extrapolated to the entire population. Inventories that include tree location may be expanded until the inventory is complete. Without tree location, partial inventories are useful only for statistical generalizations.

Complete Inventories examine the entire tree population and may include all municipally owned trees or all trees in an area. Typically, crews walk to each tree and record the required information. They can also use aerial photographs to determine tree location and condition (Maggio 1986). This type of inventory is extremely labor intensive, and thus, consumes time and money. Complete inventories can, however, provide the most accurate and most useful information about the urban forest. Complete inventories are routinely used to project budget needs, to prioritize management activities, and to achieve most other inventory goals.

Cover Type Surveys are used extensively to characterize commercial forest lands. Recently, they have been used in urban areas to quantify canopy cover and to monitor changes in urban vegetation (Rowntree et al. 1982; Oswald 1986). This type of survey is very useful for examining the entire tree population because it is not restricted to publicly owned trees. Since data on individual trees are not collected, it is better suited for use in long-term land use planning rather than to plan for work and prepare contracts. Cost is relatively low if existing aerial photographs are used. A good community pattern composite can help with cover type inventory design.

A hybrid between complete and cover type inventories are those inventories linking plant data files with the mapping ability of a CAD (Computer Aided Design) system to display maps of the vegetation (e.g. Baird 1987, Downie 1988, and Lindhult 1987). These systems are useful in high value, intensively managed areas such as arboreta, botanical gardens, parks, and perhaps even college campuses. These inventories, however, are costly and provide detail in excess of that needed for routine management of large tree populations. Many communities will be tempted by this type of inventory. This inventory is viewed as a GIS (Geographic Information System) with only the base map and the tree information layers. As street and utility departments adapt GIS technology, the urban forester could benefit greatly by adding a layer of tree information to the GIS. Such a linkage could greatly reduce the effort needed to develop the Community Pattern Composite Map. Bear in mind that a considerable amount of effort and expense is required to implement a GIS; such effort and expense cannot be justified by an urban forestry program alone.

Inventory Longevity

Inventory longevity is the projected length of time that the inventory data will provide useful information. Periodic inventories provide a "snapshot" of the urban forest and are useful for decision making and short term work planning. If repeated, they can provide information on changes in the urban forest. An alternative to the periodic inventory is the continuous inventory. After data are initially recorded, changes are recorded to update the inventory. A complete updating of continuous inventories is required after five to ten years if work crews have routinely collected information or left some areas unserviced. Updated information includes diameter, condition damage and maintenance. It is relatively easy to update a well maintained inventory. Field observations can be noted on a computer printout of all trees in the city by street address (or other locating system) Doing this will eliminate the time-consuming task of recording location, species and site information.

Data Management for Continuous Inventories

Information for small tree populations (fewer than 1,000) — such as those in parks may be maintained in a card file. For most cities, however, a computer is required to efficiently manage the massive amounts of information.

There are many variations in computer programs used to manage tree inventory data (Barker 1983). Two categories of computer programs are available: those that run on mainframe computers; and those that run on the increasingly popular microcomputers.

The earliest programs, many of which are still useful, were written for the data processing mainframe computers (Sacksteder and Gerhold 1979). These programs can quickly sort and summarize large amounts of information. This is especially important in a city with more than 100,000 trees in the inventory. If a city uses special assessments to fund tree work, processing

the tree information on the same computer as taxes allows referencing each property by its tax number, thus facilitating billing. Managing tree information on the city's accounting computer can, however, cause some problems. Access to the computer can be restricted when the city is processing utility bills or payroll. Developing a mainframe computer program may be too costly for the forestry budget. Usually it is less expensive to purchase existing urban forestry management software, if a package is available which is compatible with the city's make of mainframe computer.

Microcomputer programs are probably the most cost-effective means of managing tree data, especially for small cities. Some microcomputer programs can handle up to 150,000 trees per management area. The capacity and speed of the newer machines has increased greatly while their cost has decreased. For less than $1500, a city can purchase a computer and a printer suitable for smaller inventories. Communities with more trees would do well to consider faster computers with larger hard disks which can be purchased for less than $5000. Even this larger amount is relatively small when compared with other community forestry program costs such as training. With this equipment and a computer program for managing tree inventory data, the operator can enter data into a computer and obtain answers about the trees. Tree inventory computer programs are available from many private firms and universities (Smiley 1987, Smiley 1988). Before purchasing any program, make sure that it meets your needs. If it does not, it is not worth any price. Ask for a demonstration on your system before purchasing it. Price alone should not be a consideration; many higher priced programs provide additional features, such as printing work orders and maintaining crew productivity records.

What Data Should Be Collected During an Inventory?

After the goals of the inventory and its type have been determined, someone must decide what data to collect. Keep in mind that the more data collected on each tree, the greater the inventory cost. All data collected must relate to the goals of the inventory. One of two major problems identified with the tree inventory reported by Crossen (1989) was collection of data that was later found to have no practical value.

Species. The most commonly collected information is the tree name. Field identification of cultivars and some species is often difficult and requires experienced crews. The genus and species can be recorded, or identified by codes. Numeric codes used extensively to record names tend to be confusing and may result in mistakes that are difficult to detect. One way of overcoming this problem is to create abbreviations of either common or scientific names for the trees. Using scientific names is often less confusing than using common names. Regardless of the method, provide a complete list of names and/or codes, and a method to add codes, to those collecting data at the start of the inventory to insure that uniform terminology is used throughout.

Size. Managers conducting a tree inventory usually collect tree size data: diameter (or circumference), height and spread. Diameter and circumference are virtually interchangeable; diameter at breast height (DBH) is used most often. Recording data in one- or two-inch classes facilitates accurate determination of tree values. Managers can then compute regression equations to predict tree height and crown spread. This approach eliminates the need to measure these parameters in the field and to store them in a data base. Consider collecting actual diameter, letting the computer designate the diameter class. Diameter classes may be as small as one inch or as large as six inches. Most managers find that six-inch classes provide adequate information on large trees. Measurements of small trees are usually more accurate than those of large trees. The following diameter classes are most frequently used: 0-3", 3-6", 6-12", 12- 18", etc.

Condition. The physical condition of each tree can be evaluated to determine health or monetary value of the population. Condition does not necessarily reflect the maintenance needs of the tree. Many different methods have been used to evaluate condition, although some inventories do not evaluate condition. If condition information is required, the following classifications may be used:

- Alive or dead
- Hazardous
- Life expectancy — estimated number of years before removal will be required
- Good, fair, poor, dead
- Percentage factor — for use in the Council of Tree and Landscape Appraisers (CTLA) valuation formula

Because "alive or dead" is a poor indicator of tree condition, this classification probably should not be used. The same data collection effort applied to another method will yield much more useful information. If the tree is dead, "removal" should be recorded as a maintenance need for the tree. If a tree poses a hazard it is best to record this by indicating the maintenance required to alleviate the hazard. Only someone with a great deal of experience can accurately predict the life expectancy of a tree. This classification is not recommended because the estimates are usually unreliable. Recording tree condition using good,

fair, poor, etc. is somewhat useful, but this same information can be made available from the CTLA system. This formula for tree valuation rates condition as a percentage with 100% as perfect and 0% as dead (Anon. 1986). If tree values are to be computed, this information must be collected.

Damage or Injury. Information on tree injuries or damage can be collected and used to predict tree decline or to define the cause of future tree problems. Different types of injuries may be recorded (See list below) or the severity of the injury may be rated. Data on damage or injuries may be recorded separately or in a field for history or remarks. It should be noted, however, that collecting information about insects, diseases and other injuries is pointless if it is not used after collection. Why collect it? If no management action will be taken, there is little advantage to recording the information in the inventory. One approach to consider is to record insects and diseases only when they require some specific management action, i.e. only when there is a reasonable chance that someone will be sent to do something about the problem. Then, the information could best be recorded as a maintenance need. For example, instead of recording that fire blight is present, record the need for sanitation pruning. If dealing with a widespread pest such as aphids on Norway maples, simply use the inventory information to identify all susceptible trees rather than recording the need for a dormant oil application for each tree.

Classifications of injuries commonly recorded in tree inventories.

- Mechanical injury
  - Branches
    - Utility or improper pruning damage
    - Breakage due to wind, snow, lightning or people
  - Trunk
    - Mower/string trimmer
    - Auto
    - Construction
    - Vandalism
    - Fire
    - Lightning
  - Roots
    - Curb replacement
    - Sidewalk replacement
    - Underground utilities
    - Construction

- Pest injury
  - Insects
  - Diseases
    - Decay/Cavity
    - Dieback
  - Mistletoe
  - Rodents
  - Bird

The tree inventory collects information about trees. It differs from a pest survey, which is designed to detect pests and gather information about present and potential pest populations (Laut 1978). Surveys should be ongoing, while even a continuous inventory is relatively static. Pest survey information can help to determine when management is needed and to develop strategies to reduce pest impact. Pest surveys may be conducted during an inventory by noting pest conditions on a sample of trees examined. These data need not be entered into the computer with the inventory data.

Management/maintenance Needs. Management needs are perhaps the most important part of an inventory designed for management use. The tree inventory information is useful in preparing budgets, scheduling work and assigning crews. Required management can be recorded by the type of work (See below) or by the equipment needed and/or time of year to do the work.

Categories of maintenance needs commonly used in tree inventories.

- Pruning
- Tree removal
- Stump removal
- Sidewalk and/or curb repair needed
- Vacant planting sites
- Fertilization
- Insecticide spray
- Fungicide spray

If the type of work is recorded, code the specific type of pruning: small tree training, dead wood removal, hanging branch removal, sucker removal, lifting lower limbs, sign or light clearance, and pruning pest-infested branches (sanitation). Combining tree-size information with management requirements makes it possible to prepare accurate budgets and to allocate equipment.

Pruning and other management needs may alternatively be coded by equipment and/or personnel needed and the best season for doing it. This allows scheduling all the work in an area that requires a bucket truck, or all work that should be done in April. Coding for management needs in this way requires well-trained crews able to do the correct work on each tree.

Tree Location. Many methods have been used to determine tree location. Street address is probably most useful, especially when the data will be used to respond to resident requests. Where there are several trees on a lot, they can be separated in one of several ways: mapping exact location of each one; measuring the distance from the lot line (or driveway) to each tree; numbering (or assigning a letter) from the lot line (Figure 5-6); or dividing the lot into numbered cells and recording the cell number for each tree (Figure 5-7). Other methods include numbering trees from an intersection of two streets, measuring the distance from the intersection of two streets to each tree, using property tax numbers to identify each lot, using a grid system for the entire city, or mapping trees using aerial photography. Morsink and Burridge (1986) maintained information about trees on each street by using house numbers, beginning with the lowest house number. As they encountered each tree, they recorded its distance from the curb. Other sequential tree numbering systems may not work well when trees are planted or removed. The grid cell method is probably the best method, especially when the inventory area includes trees along streets and in more open spaces. However, any method will work as long as it allows crews to locate each tree. Linking each tree to a street address makes it much easier to contact and communicate with property owners. When planning an inventory, consider the time to locate a tree versus the need for accuracy. Other information collected for the tree, most notably species and diameter, may help identify the desired trees on a lot.

Some authors recommend mapping the trees as they are inventoried. This practice, rarely necessary, is expensive. Only the street address of each tree is needed in order to respond to homeowner requests and to set up city and contract maintenance.

There is strong justification for organizing the community into smaller management units or work areas of 1000 to 3000 trees. Reducing the number of trees in a data file greatly decreases the time required by a computer to access information about a given tree.

Site Characteristics. Site characteristics determine tree species or types that will thrive there. One of the most important factors is the space available for the root system. For example, a two foot space between street and sidewalk does not provide enough room for planting. Overhead wires also limit species selection. Recording the presence, or better yet, the height of wires greatly assists in determining species or cultivar to plant and what maintenance will be required afterward. Most utilities maintain a 10 foot clearance in all directions from wires; hence, mature trees should not infringe on this clearance area. Underground utilities may restrict the use of trees sensitive to root damage. Land use information can help identify high priority areas for tree planting and other maintenance. Residential, commercial, industrial park, or other categories all provide useful information when planning for tree planting and maintenance.

Planting Spaces. Where planting spaces exist, coding can be arranged to fit with the regular species information. It is important to identify tree planting spaces and indicate the size of tree capable of growing in the space available. In many new residential subdivisions, treelawns at streetside and in yards are nearly treeless. A planting space inventory helps advocate correction of this "barebones" condition (Figure 5-8).

Other Information. Other data collected should relate directly to the management needs, inventory goals, and inventory type. Information which will not be used slows data collection and increases inventory cost. Information concerning the historic or aesthetic value of trees helps to identify "key" trees in locations where more intensive management is warranted; moreover, this information is often used to justify the inventory itself. The date of the last change to a record may also be of interest.

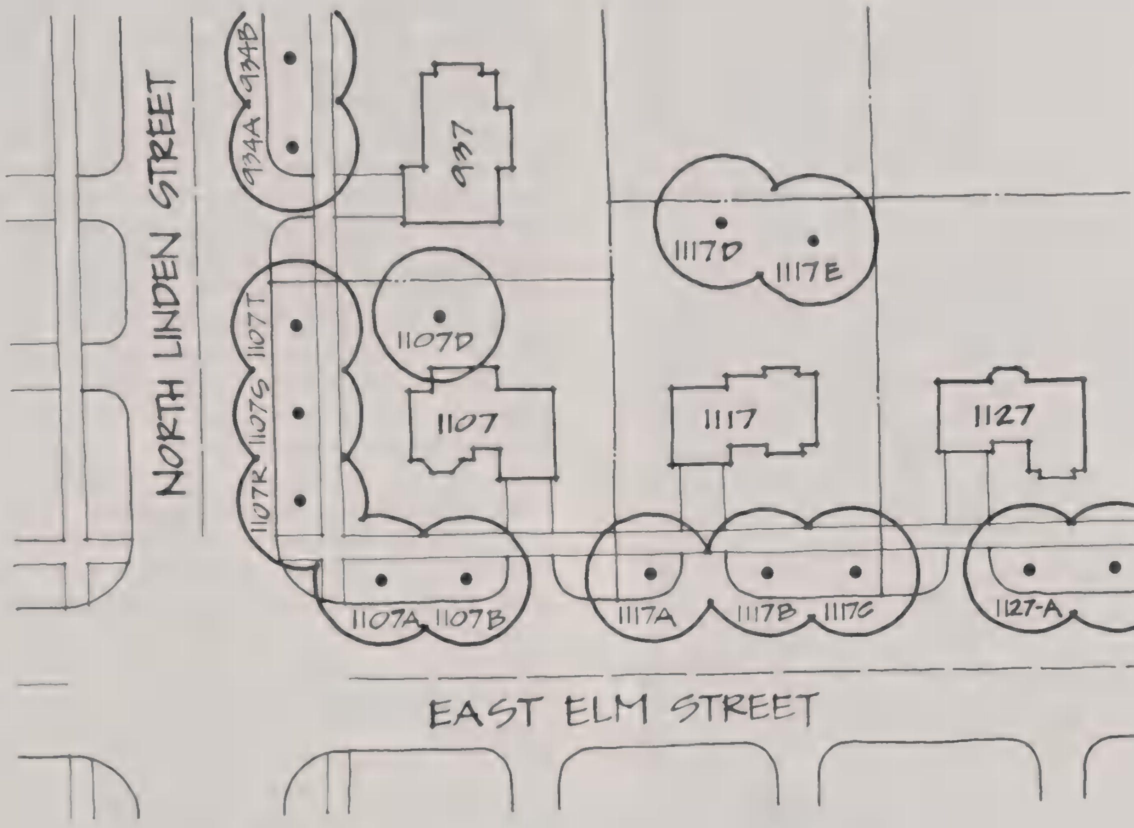

Figure 5-6. Lotline/Letter Method for Locating Trees

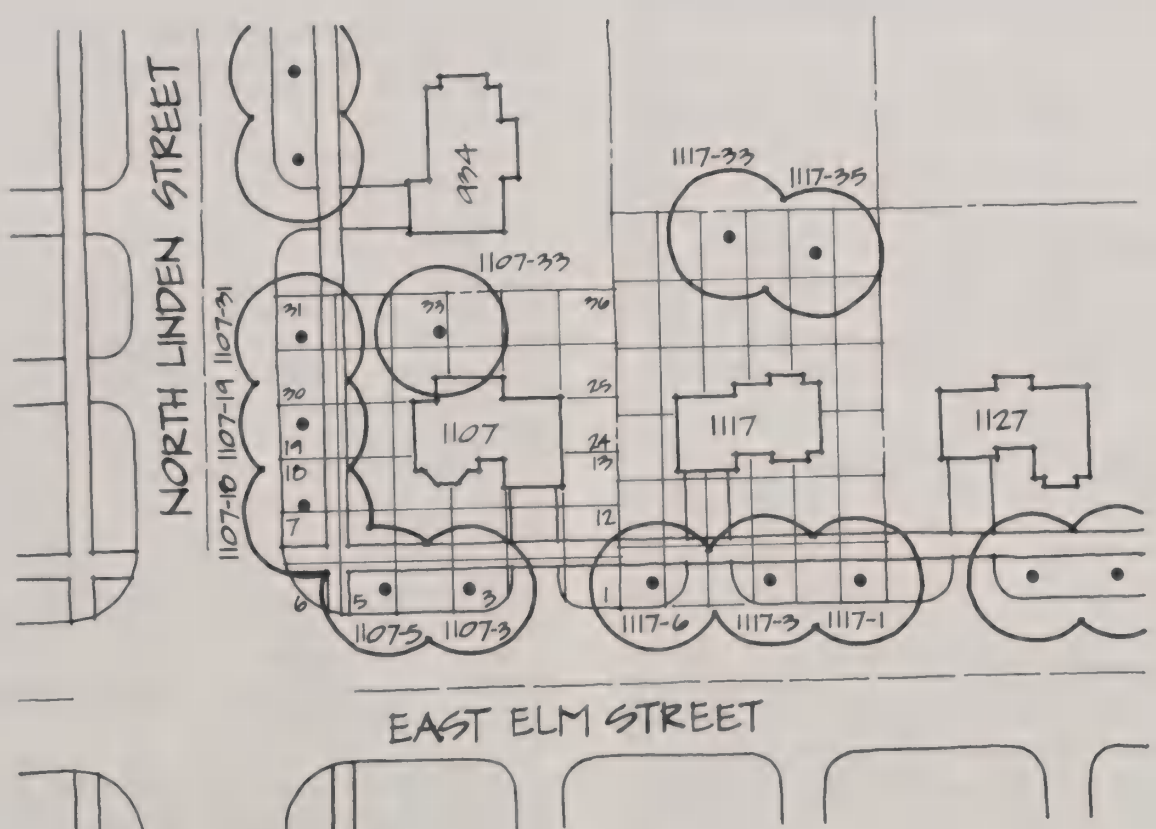

Figure 5-7. Grid/Cell Method for Locating Trees

Figure 5-8. "Barebones" Residential Subdivision

Budgeting for an Inventory

Funding often dictates many decisions. The major cost of any inventory is field data collection. Collecting only basic information requires that an average college student spend from one to three minutes at each tree. More time is required by less experienced workers.

When planning the labor requirements for a tree inventory, consider the time required to collect data, to travel from place to place, time to supervise for quality control, and to enter data into the computer and verify it. Quality control requires field checks on a sample of the data. If problems are found, more extensive checking or recollection is required. Verification involves checking data entered into the computer. For each hour allocated to collecting data in the field, allow at least 1/2 hour for data entry and verification and 1/4 hour for quality control. Data-entry time can be reduced greatly by using hand-held data recorders in the field. Shock-resistant, waterproof dataloggers as well as portable, battery-operated microcomputers have both proven useful. The portable micro computers are more fragile but less expensive. Data collected on the streets are transmitted into the office microcomputer and are instantly available for use. The programs used to record the data can reduce errors involved in data entry, such as omitting a field or entering a letter where a number is required. Some of these devices will accept input from a bar code reader, further increasing speed and accuracy in the field. While the cost of field data collecting equipment may be quite high from $300 to $3000, the savings in labor cost usually offsets the initial equipment expenditures in all but the smallest computerized inventories. A community which has no firm plans to use the field data collecting equipment after the inventory would be wise to consider renting it.

Transportation to the inventory area and from one tree to the next can be a major expense. During a windshield inventory, from one to five miles of streets (depending on the number of trees involved) can be covered each hour to collect minimal information. Surveyors inventorying a specific problem can cover five to ten miles each hour, unless the problem is widespread. Walking between trees in well forested cities typical of the midwest or east may require from 30 seconds to two minutes. In cities with fewer trees, using bicycles or mopeds will reduce long walks between trees.

It is best to inventory several typical blocks to determine the time required to collect data and move from tree to tree before preparing a budget. A projection can then be made for the entire inventory unit. If the sample will be used to prepare a fixed budget request, a statistically valid sample may be needed.

Urban forestry consultants will bid on inventories by street mile, as a lump sum, or by the tree. Consultants commonly bid a fixed amount for each tree or planting site inventoried. This practice reduces the consultant's risk of underestimating the tree population. The other methods provide a total cost figure which makes municipal budgeting more definite. Consultants currently charge between $1.80 and $2.50 per tree, depending on location and the amount of information to be collected. They usually include computer data entry and verification. If a grid system is to be used and exact tree locations are required, the price may more than double. Usually, consultants can inventory between 150 and 200 trees a day.

Funding an inventory is simplest if it can be included in the tree maintenance or public works budget, but there are other options. Another city department, such as public safety, may share the expense since results, especially regarding traffic

signs and lights, are useful to them. Utilities may partially fund the examination of trees under their wires. Utilities spend millions of dollars each year trimming interfering trees, and there can be considerable savings if an inventory helps reduce trimming. The state government may have its own urban forestry budget or pass through urban forestry funds from the USDA Forest Service. Check with your state urban forestry coordinator. Several cities have used federal funds from the Summer Youth Employment Program (SYEP) to hire youth to collect data. These funds are usually controlled by the local Private Industry Council or Job Training Partnership Administration. Private donations of time or money can also be used for tree inventories. An organizer or fund raising committee must prepare and present project proposals. Contact large companies in the city to determine the availability of grants for civic projects.

How to do the Inventory

After setting inventory goals, deciding what data to collect, and planning for data management, the person in charge of tree care must decide who will collect the data. Personnel, budget and time available for the inventory will influence this decision. Options for data collection and computer entry include:

- Hiring a consulting firm to perform all or part of the inventory
- Hiring additional full time or summer help
- Reassigning existing personnel
- Using state funded personnel
- Using community volunteers
- Using youth in the SYEP program

Many cities choose the first or second option because their personnel have other responsibilities. When hiring additional people or using volunteers, remember that they must be trained and supervised. The crews must be able to identify city trees and must also recognize maintenance requirements and tree condition. Contracting with consultants obviates the need for extensive training or supervision. Consultants are also available to train existing or summer staff and to supervise them during data collection. Graham (1987) discusses some of the advantages and disadvantages associated with the use of volunteer labor.

Crew Size

There are diverse opinions about crew size. For windshield surveys, the optimal size is at least two. For other types of inventories, crew size can be one or more. Early in the inventory, crews of two can interact, which helps entrench the protocols. Later, however, unless detailed measurements are being taken, individuals can be much more productive. Also, larger crews attract more public attention. This may be good or bad, depending on your objectives. Well trained crews, who have a professional appearance and carry a supply of brochures for informing the public about the urban forestry program and the tree inventory, can be an effective public relations asset, at a cost of some productivity. Most urban forestry programs can benefit from the increased publicity. In any case, crews should dress neatly and, if possible, wear uniforms (caps, jackets, or shirts) that identify them as city employees. Official ID cards are not a bad idea. Another factor that must be considered in determining crew size is the "type of neighborhood." In some areas, crews of two or more are required for crew safety.

Vehicle availability can also restrict crew size, but placing crews in the same general area will minimize this constraint. It is often a good idea to have crews in the same area so that there are more people available to deal with problems that may occur.

Crew Training

Even the most experienced crews require some training prior to and during the inventory. This includes training crews to recognize the prominent trees in the inventory area, to rate management needs, and to use the CTLA tree valuation system if tree values are to be computed. An extremely important but often overlooked aspect of training is to develop and use uniform protocol for collecting data. Without strong protocols, data collected by one crew means something different from that collected by others. Prior to the inventory, a working set of protocols needs to be established. For example, how is a crew to handle trees forked below breast height or trees of unknown species? The categories of each possible code for each field must be described as explicitly as possible. Taking crews to a few sample blocks and discussing the values they would record for each tree can be very beneficial. Crews should meet at least weekly, and perhaps daily during the early phases of the inventory to discuss problems and change the protocols if necessary.

Quality Control and Data Verification

Maintaining quality in the data is an extremely important step that is often neglected. The axiom "garbage in — garbage out" applies. We have discussed how to develop protocols to ensure that data collected by one crew has the same meaning as that collected by others. Here we are concerned with errors that can become a part of the data set at several points in the inventory process. Crew members can make mistakes in

identifying the tree or data item, in measuring size, or in locating the tree. They may also omit trees or some data for a tree, or they may err in recording the information. Very early in the inventory process, the inventory supervisor should recheck a subsample of each crew's work in the field. An unacceptable error rate warrants additional training. One can make a strong argument in such cases for supplementing the training of all crews. As the inventory progresses and the crew gains experience, their error rate will probably decrease, but quality control should continue, perhaps at a less rigorous level.

The other major source of errors in the data occurs during data entry into the computer. These errors occur through mistyping. Data integrity can be maintained by checking data printed from the computer against the field data sheets. Some data entry programs require that data for each tree be entered twice. The computer compares the two entries for the same data, and flags any differences. The principle is that a good typist will not make the same error twice. Unfortunately, few urban foresters are good typists. There must be a process for handling incomplete data sheets. These records should not be entered into the computer but referred back to the field crews for completion.

Those crews using data recorders in the field will find this to be a simple process. The data entered into the files must still be checked against the population of trees in the field, but the mistyping errors should not be a problem because these programs should check for valid responses. Perhaps more of a problem is making sure that each day's data is transferred to the larger computer and that all of the information gets there. Fortunately, most data entry programs protect against these errors.

A caution is warranted. The inventory will have errors in it because it is impossible for humans to deal with this much information without making errors. What is needed is a systematic means of detecting these errors so that an uncertainty factor can be incorporated when the data are interpreted and so that some of those errors can be corrected.

When to do an Inventory

Inventories are usually conducted during summer months to take advantage of students and favorable weather. Foliage may easily be evaluated and condition classified. Collecting data when trees are dormant has several advantages because trees can more easily be examined for dead wood, hanging limbs and other conditions that leaves may obscured. Personnel may have more time for the inventory because their workload may be reduced during the winter. Many professionals successfully conduct winter inventories

Updating the Inventory

The data collected during an inventory represent a "snapshot" of the tree population at a point in time. The actual population will change, often very soon. The urban forest manager can control some of this change through planting and removing trees. Some changes are beyond his control, such as damage from a severe storm. Other changes can escape detection, such as the homeowner who removes trees on the weekend. These changes must be considered as the inventory ages.

In a complete inventory with recorded tree locations, city or contract crews may keep accurate records of approved maintenance and removals if they record these operations for each tree as they complete the work. Tree management computer programs make this process very simple. In a small city, the information can be recorded on the notecard for each tree. However, depending on the level of tree maintenance, updating the inventory becomes necessary. Most computer programs are able to print the information for each tree in a format suitable for field use. Changes can be recorded on these sheets, and later entered into the computer. Those communities using the held-hand data recorders can move the data files from the larger computers, bring up the record for each tree as they encounter it, and make the necessary changes. Keep in mind the need for uniform protocol and for data quality control.

Tree Valuation

Tree valuation — the process of assigning a dollar value to each tree — is the objective of many inventories. This process allows managers to estimate the overall value of the tree population.

The CTLA valuation system involves determining the cross-sectional area of the tree at breast height (4.5 feet above the ground) and multiplying by a dollar value per square inch of cross-sectional area. This gives the maximum possible or basic value of a tree that size. Deductions are then made for the tree species, location, and condition. The details are clearly discussed in the publication by Neely (1988). This publication should be provided to all inventory crews who will collect data for tree valuation. Furthermore, they should as a group be thoroughly trained in the use of the system. Well trained crews will collect information that is more reliable and more useful.

The information needed for tree valuation is usually recorded during the tree inventory. The computer program which manages the data will calculate the tree value and usually provides a total for the entire management unit. These value figures can be extremely helpful in justifying budget requests. They can also be used in cases involving damaged trees. However, if litigation is or could possibly be involved, an on-site valuation of the trees and surrounding area is absolutely essential. This should be done by the most experienced plantsman available to the city. The city may wish to hire a qualified consultant. Tree values are estimates based upon the subjective estimation of the individual involved. Rarely do two experts agree on the value assigned to a tree, although they should be close. When there is a disparity, the opinion of the individual with the most experience is often given the greatest weight. Even if you are likely to be the "most experienced," recognize that there will be some negotiation. Record all the information you can. Take photographs, for they are even better. Use the tree inventory data only as supporting evidence.

Portions of this chapter on tree inventory are based on a manuscript by Smiley, E.T. and F. A. Baker entitled "Options in Street Tree Inventory," which appeared in the 1987 *Journal of Arboriculture*, Volume 14 pages 36-42.

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VI. COMMUNITY FOREST PLAN

Community Forest Plan Map
- Community Image
- Planting Design Pattern
- Tree Size
- Longevity
- Design Guidelines
- Tree-Type Categories
- Drawing the Community Forest Plan Map
- Tree Lists for Tree-Type Categories

Community Forest Plan Report
- Documentation of Goals and Objectives, Ordinances and Policies
- Documentation of Decision Criteria
- Program Priorities

VI. COMMUNITY FOREST PLAN

COMMUNITY FOREST PLAN

In many ways preparing the forest plan is the most enjoyable and yet the most difficult task in the entire planning process. Enjoyable because the previously gathered information will finally be synthesized and utilized to design a comprehensive planting pattern for the entire community. Difficult because selecting the appropriate patterns will require careful study and artful diplomacy in reaching a consensus among Shade Tree Commission members. The document produced, a community forest plan, is comprised of two parts:

1. The **forest plan map** showing the planting pattern for the entire community.

2. A brief **forest plan report listing inventory results, evaluation and goals and objectives of the Tree Program.** The criteria used to make the decisions about planting pattern are explained also. The report should include related **ordinances and policies** and a list of **program priorities** for the long-term management of the community forest — priorities based on the Community Pattern Composite Inventory, the planting pattern, the tree inventory, tree-care needs, and tree-care budget.

The overall objective of the Forest Plan is to achieve visual and spatial unity within the community. The plan should reflect the long-term goals established by the Shade Tree Commission and reinforce the desirable community pattern elements identified in the community pattern inventory. It is a functional tool, a reference for future action. The plan is dynamic and must be frequently updated to respond to the changing community context. The ordinance is the legal document designed to insure that the goals and objectives embodied in the plan are realized in the day to day decisions of elected officials and department heads. The Forest Plan does not directly address the non-visual and spatial benefits of trees such as climate control, screening etc. These uses of trees are best studied at the project site scale and are discussed in the project site evaluation section.

Community Forest Plan Map

Arnold (1980) noted, "Trees are the most useful design element capable of linking together the diverse elements of an entire city" (Figure 6-1). The linkage which Arnold describes cannot possibly be achieved if a forestry program proceeds on a project-by-project basis without the guiding framework provided by a community forest plan. Decisions in two general areas should be made in preparing the map:

1. Planting Design Pattern: formal, informal, combination, wildlife habitat.

2. Tree Size: large, medium, small, mixed.

Figure 6-1. Trees Can Unify Diverse Architectural Styles

The decisions made in these two areas will have more impact on people's perception of the community than any other community forest-related decisions. That is why they are the major focus of the Community Forest Plan Map.

Planting patterns should relate to planting opportunities. Since each community pattern is unique, it is impossible to present detailed forest planning ideas about planting pattern and tree size that will apply to all cities and towns. There are, however, basic principles which the Commission or others responsible for preparing the forest plan map should adhere to.

Community Image

Residents experience their communities as sequences of spaces and places within which they live, work, and play. To function comfortably and efficiently, each resident constructs a mental map of the community, a pattern of key visual cues that define and link spaces and form places. Kevin

Figure 6-2. A Community With a Strong Image Provided by Trees

Lynch (1960) described these cues as image elements and listed them as paths, edges, nodes, districts, and landmarks. Streets and sidewalks were identified as key path elements. It is from paths that residents construct much of their mental maps. Research by Lynch and others further suggests that streets and sidewalks nicely defined with street trees have a high image quality, the quality that makes them part of most mental maps. Communities with a high image quality are understandably comfortable to reside in and appear hospitable to visitors (Figure 6-2).

Planting Design Pattern

In general, there are four basic concepts for planting trees in urban environments: formal, informal, a combination of the two, and planting to provide wildlife habitat. Plantings based on each concept create a pattern which has distinct advantages and disadvantages. Ideally, the Shade Tree Commission, staff or consultant should select the concept that best fits a specific area of the community. In addition, there are other specialized planting patterns used to solve specific functional problems such as erosion control, slope stabilization, wind protection, or screening. These planting patterns are applied to site specific situations and are generally not considered when preparing the Forest Plan.

Formal concept. Formal planting emphasizes geometric patterns, a limited number of species and uniform spacing. Henry Arnold, in his book *Trees in Urban Design*, strongly advocates this approach to community forestry. "Spatial definition using trees becomes more coherent with repetition and continuity" (Arnold, 1980, p. 43). As a means of unifying the diverse elements of a city, a geometric theme is the strongest of the three approaches. Figure 6-3 illustrates the formal concept.

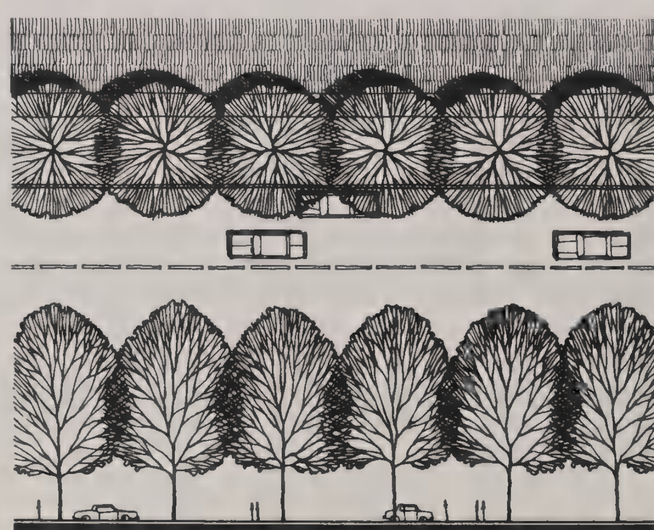

Figure 6-3. Formal Planting Concept — Large Trees

As a general rule, formal plantings are most appropriate when related to a grid or other

geometric systems of streets within an existing identifiable pattern. Formal planting is also well suited to narrow planting strips where there is insufficient space for groupings of trees. Many of the most elegant tree plantings in the Interior Western states are composed of rows of a single species lining both sides of the street. Formal planting is also useful as a technique for emphasizing major arterial streets, especially if large, visually dominating trees are planted (See Figure 6-3). Usually trees with formal characteristics are most appropriate in formal planting schemes.

A formal style of planting can also be applied in designing parks, cemeteries, church grounds and the landscape around public buildings. In these cases the formal plantings may be used to create a visual and spatial enclosure within which more informal arrangements of trees can be placed.

Because formal plantings frequently rely on a single tree species for design effect, such plantings concern foresters and ecologists because a sizable proportion of the community forest is susceptible to one disease or insect. The Dutch elm disease epidemic is a tragic example of how one pest may drastically affect the entire community forest. The aesthetic value of single-species or monoculture planting needs to be weighed against this potential problem. A compromise solution is to plant several different species that are similar in size, form, color, and texture (green ash and kentucky coffee tree, for example).

Informal concept. The informal style of planting emphasizes clustering, planting a variety of species and spacing the plantings at irregular intervals. It has been and remains a popular way of planting trees in virtually every zone of the community environment. Landscape architect, Jens Jensen, an untiring advocate of the "naturalistic" concept, wrote in **The Clearing,** "There are those who think the parks in our cities should be more along the straight lines of the city. It might seem a great stunt to have our parks developed along straight and rigid lines; but how can the human form with its many curves fit into such a scheme. What the city man needs is an expression of freedom in everything he comes in contact with to counter-balance the city's straight jacket" (Eaton, 1965, p. 96).

An informal style is perhaps most appropriate in large spaces, such as parks, where planting provides variety and relief from the grid pattern of streets and houses. It is also well suited to hilly terrain where roads with irregular alignments follow the landform. Informal planting is most appropriate where development has been constructed in stands of natural vegetation. Along the Black Hills of South Dakota, new benchland development is occurring in natural stands of ponderosa pine, and oak. Informal planting, incorporating the native species, can effectively integrate these developments into the natural landscape as shown in Figure 6-4. As a general rule, informal planting in planting strips adjacent to streets is applicable **only** if the area for planting is wide (15 feet or more). Without sufficient width in the planting strip, the desired informal effect cannot be achieved.

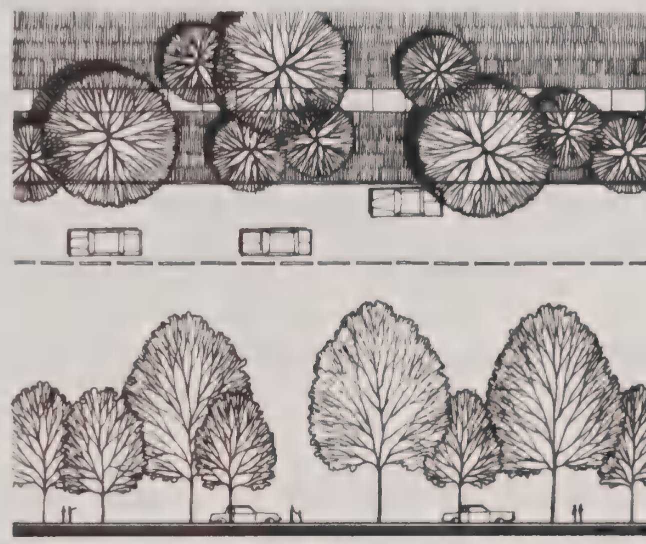

Figure 6-4. Informal Planting Concept — Mixed Tree Sizes

Combined concept. The third approach combines the two concepts, applying formal or informal planting in those areas within the community in accordance with the style that seems most appropriate for the area. The difficult design task in applying a combination of planting concepts is in dealing with the transition zones between the two. Without subtle transitions the overall plan can appear haphazard and compromise the goal of aesthetic unity. Figure 6-5 shows a combination of the formal and informal planting concepts.

Wildlife habitat concept. A planting concept designed to attract and sustain the native birds and animals that reside in and visit urbanized areas uses an approach that is the opposite of the formal concept. The wildlife habitat concept emphasizes irregular planting patterns, a diversity of plant species, sizes and ages, and plantings that are connected and continuous, rather than small, or isolated.

Wildlife habitat plantings are most appropriate in and near areas of existing or potential habitat value, such as river or stream corridors, irrigation canals, power or rail rights of way, and unbuilt areas such as steep slopes or wetlands. Areas that should be considered for addition of wildlife habitat plantings include large publicly-owned grounds. Golf courses, parks, schools, and cemeteries fall into this category.

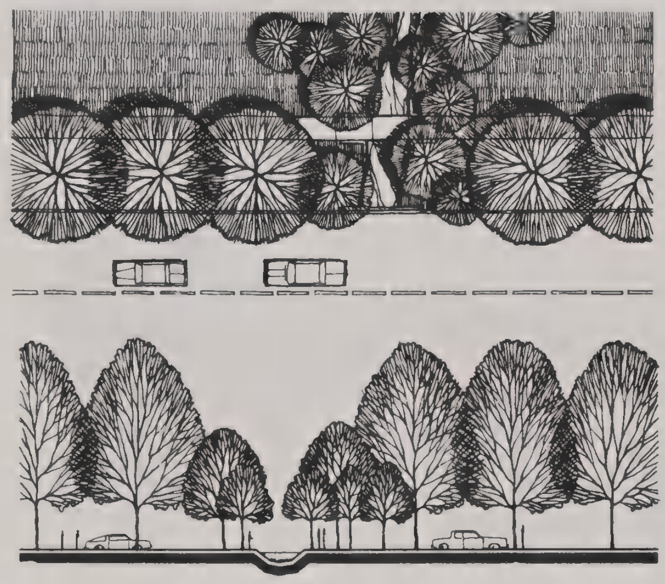

Figure 6-5. Combined Formal and Informal Planting Concept — Mixed Tree Sizes

Figure 6-6. Wildlife Concept— Mixed Tree Sizes, Shrubs, Grasses and Forbs

Habitat plantings consist of groupings in which the three vertical layers of vegetation — ground cover, shrub, and tree canopy — are equally represented (Figure 6-6). Curvilinear edges of the planted areas are planted with a diverse selection of plants. Mown turf areas are minimized or eliminated. Where habitat plantings are integrated with existing riparian or utility corridors, maintaining the linear and connective qualities of the vegetation are planting objectives. In larger public use areas, such as golf courses, wildlife habitat plantings are circular or curvilinear in shape, with a predominance of trees in the interior, and a variety of shrubs, unmown grasses, and ground covers at the edge. Native plant species predominate, along with ornamental plants that have food or cover value for birds and animals. (Appendix D provides a list of wildlife resource plants.) Variety in tree structure is emphasized and multi-branched, naturalistic tree species or varying sizes and ages are planted.

Since wildlife habitat plantings often appear to be different from the more traditional urban forest plantings, placing interpretive signs in these areas will help inform residents of their purpose and enlist their support for the program. The signs should explain the objectives of the plantings and inform the public about the many benefits of such areas to both human and wildlife residents of the community. Cooperating with local Audubon or native plant societies, garden clubs, schools, or scouts will get these community members involved in urban wildlife projects and develop a broader base of public support for the plantings.

Tree Size

The size of trees in height and spread has more visual impact during a year than any other characteristic. Larger trees are visually more dominant than medium or small trees. As a general rule, large trees should be used to emphasize the most important elements of community pattern. Medium and small trees are useful in situations where narrow planting strips, utility lines or other physical limitations rule out the use of large trees. A combination of trees with a variety of mature heights may be appropriate for informal planting patterns. The use of mixed tree sizes accentuates the natural feeling of informal plantings.

The guidelines listed below are intended to aid Shade Tree Commission Members in developing criteria and in making decisions about planting pattern and tree size.

Longevity

Planting trees is a long-term investment in the future of a community. In general, those species with a long life expectancy are recommended for all street tree plantings, particularly formal plantings that define major arterial streets. It is also advisable to plant long-lived species adjacent to city hall, courthouse, library, and other public structures. Planting and maintaining long-lived species in these locations will insure that the benefits trees provide will be enjoyed by many generations of community residents.

Trees with a shorter life expectancy – typically fast growing trees – have a place in plantings for playgrounds, parks, wildlife habitat, and similar sites where a quick effect is desired. Thinning of the original planting and planting of long-lived species 10 to 15 years after the initial planting will extend the effective life of the original planting well into the future. In special situations frequent plantings of fast-growing trees or maintenance practices that promote regrowth may be necessary to provide the type of habitat required by some wildlife species. It is advisable to consult with state wildlife biologists for help with all habitat plantings.

Design Guidelines

Within any design project, unity is achieved by adhering to the design principles of continuity, balance and emphasis. Continuity in the forest can be perceived at the community level; balance and emphasis will be experienced at the project site scale. In a community forestry plan these principles must be applied to both the composition of trees and the selection of species. There are several general ways that the above-mentioned design principles can be applied to developing a Community Forest Plan Map.

1. **Develop a bold, straight-forward plan that will become the theme for the community forest.** Select a planting design concept that fits the unique needs of your community and stick to it. This is one of the best ways to insure continuity in the community forest. Most small communities will find that a combination of formal and informal planting will best compliment their typically diverse pattern. This combination should be supplemented with plantings for wildlife in suitable locations.

2. **Plant trees to delineate spaces, plant species appropriate for the purposes served by the spaces.** Streets and sidewalks function as conduits for movement. Think of planting in planting strips adjacent to streets and sidewalks as defining – at maturity – a tunnel with the "floor" defined by the road and planting strip or tree lawn, the "walls" defined by the tree trunks and foliage, and a "ceiling" of the canopy of branches. Using this concept will assist in visualizing the Community Forest Plan as a means of forming visual and spatial sequences with high image quality along community paths.

3. **Select a group of plants for the community forest which have similar forms, colors and textures.** Limiting the number of plant materials to be used and selecting a majority of plants with similar characteristics reduces the possibilities of glaring contrasts in planting and resulting visual confusion. However, a limited number of plants with contrasting characteristics may be included for emphasis. The number of plants selected must, however, be large enough to include large, medium and small trees and contain plants with a range of environmental tolerances to meet the varied growing conditions in the community.

4. **Use bold plantings to emphasize major community pattern elements, particularly arterial streets.** Since major arterial streets are usually the widest, tall trees evenly spaced with large crowns at maturity will emphasize the streets effectively. In the Interior Western region Sycamore, Green Ash, and Norway Maple are used extensively to emphasize major community pattern elements. The Sycamores planted along Main Street in Brigham City, Utah, are an excellent example, as illustrated in Figure 6-7. Plantings to emphasize community pattern need not be of one species only, although the visual effect of a monoculture planting is stronger than a mixed planting.

The key nodes in any community are special places, such as the main entry into town, major intersections, public buildings, parks, and other places of significance. Using trees to emphasize special places in the community will enhance image quality as well. Emphasis can be achieved

Figure 6-7. A Bold Planting Concept Emphasizes Main Street in Brigham City, Utah

in a variety of ways but most often by contrasting with the immediate context. For example, the entry walk to a community library could be emphasized by planting a cultivar with pyramidal form to provide a contrast with the rounded form of the parent species used in the planting strip along the street (Figure 6-8).

5. **Plant the same species or species of similar form and size on both sides of the street.** A visually balanced planting is essential to unity. The street creates a visual sight line for both the driver and the pedestrian. To insure a balanced view along the sight line requires that the same tree species, or species of similar character, be planted on both sides of the street. Where utility lines or other physical limiting factors make this impossible, select a large and small tree species of similar form, branching habit, color and texture to use on opposite sides of the street. Avoid strong scale contrasts between large and small trees, particularly at street intersections.

6. **Match tree size to street width and the available space in the planting strip.** This generally means using larger trees adjacent to wider streets as shown in Figure 6-9. Large trees are also preferred for narrow streets, but if the scale of adjacent architecture is small or the planting strip narrow, then medium or small trees may be preferable as shown in Figure 6-10. "Large trees have an extraordinary flexibility in complimenting a range of spaces from the size of a small back yard to a regional park" (Arnold, 1980, p. 81).

Develop rhythm in plantings to enhance visual unity in the community. Strong, visually obvious rhythm can be achieved through a regimented spacing of tree trunks and a geometric alignment. More subtle rhythms are possible by varying these factors as well as tree size, form, color, or texture in carefully designed ways. Alterations of tree size or form are appropriate to enhance the rhythm of a formal tree planting pattern. Where there is ample planting space, irregular trunk alignments and more dramatic variations in tree size, form, color, and texture produce a visual effect appropriate for informal or wildlife planting design patterns.

7. **Space trees an appropriate distance apart.** Normal spacing for large trees in this region is 30 to 40 feet on center if some canopy overlap is desired. Trees with spreading crowns may be placed farther apart; however, spacing trees too far apart, greatly reduces their ability to define space and visually unify the community.

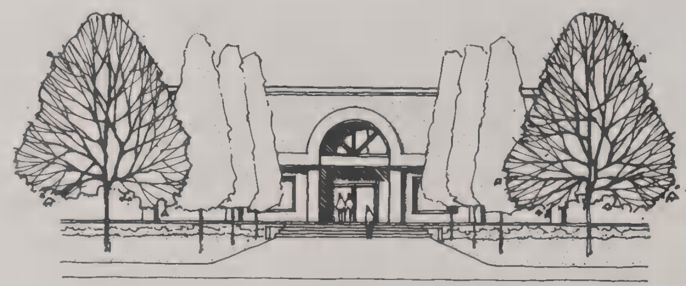

Figure 6-8. By Changing Plant Form Important Community Structures Can Be Emphasized

Figure 6-9. Large Trees Used to Enclose a Wide Street

Figure 6-10. Medium-sized Trees Used to Enframe a Narrow Street

> The distance between trees must be established on an aesthetic basis giving consideration to scale relationships, surrounding geometry, paving pattern, height (and spread) of canopy, rhythm of movement through the space, light quality and desired tree form. Valid cultural limitations include the spread of branches and roots when planted, soil type and condition and circulation in the space (Arnold, 1980, p. 48).

The cultural limitations mentioned above are discussed in the plant lists provided in Appendix C and the Tree Selection Matrix in Chapter IX.

8. **Complement existing vegetation.** In developing the Community Forest Plan Map, it is generally preferable to plant the same tree species or mixture of species as those already in the planting strip. This helps establish unity within the planting. However, if the existing tree species are undesirable, a more desirable species can be planted adjacent to the existing trees. Over time the undesirable trees can be removed. Because trees grow slowly in the Interior Western region, a healthy tree should not be removed simply because it does not fit into the ultimate effect desired in the master plan.

9. **Provide Transition Plantings.** Transition plantings are plantings which meld the structural characteristics of one planting design into another, eliminating sharp visual contrasts between the two. Consider transition plantings between formal and informal planting design patterns and between any new pattern and the adjacent undisturbed landscape. In wildlife and informal plantings, create curvilinear planting patterns that flow across the rectilinear elements imposed on the landscape (Figure 6-11).

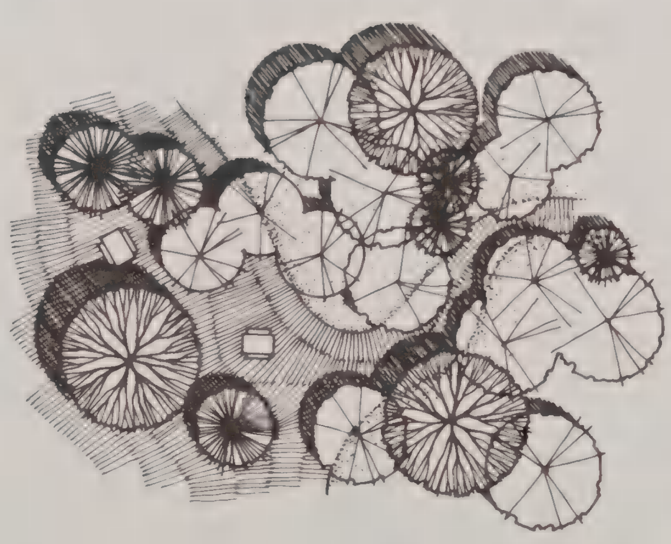

Figure 6-11. A Transition Planting Melds a Wildlife Habitat With an Urban Park

10. **Retain, enhance, and where necessary rehabilitate existing vegetation on stream banks and steep slopes or unbuildable areas.** Because landscapes adjacent to water are scarce in the arid west and are so important to wildlife, they deserve special attention. The dominant trees are large, often the tallest trees in town and, hence, highly visible. Beneath these dominant trees a rich understory of small trees, shrubs, and ground covers, provides a varied contrast with the surrounding landscape and provides the sort of structural diversity favored by wildlife. In many places the landscape around streams, lakes and ponds constitutes the last remnants of a native plant community. For this reason, any development in such areas, which are usually rich in native plant material, should be undertaken carefully. Remove existing vegetation only to correct problems caused by nuisance or invasive trees. Grading, cutting or filling earth should also be minimized to avoid unnecessary stress on trees. For supplemental planting, native (indigenous) plants are recommended. Using native plants retains the integrity of the riparian landscape, which contributes to visual diversity in a community and supports those wildlife species that have co-evolved with the vegetation. Replanting with indigenous plants is also recommended for waterfront sites where all existing trees were previously removed.

Smaller communities still have means of conserving and properly managing this valuable resource. They can purchase water frontage outright, negotiate for public easements, apply flood plain zoning concepts, prepare performance standards or simply work directly with property owners. The communities in Bear Lake County, Idaho, have, for example, protected their riparian vegetation through a recently passed ordinance to protect stream side and riparian vegetation. The Shade Tree Commission should explore the above strategies for incorporating riparian corridors and other stands of vegetation into the community forest.

11. **Match planting concept, tree size and spacing with the adjacent land use.** Although the list of land use types could be subdivided endlessly, we have chosen six general categories to discuss: commercial, commercial strips, residential, industrial, institutional and special forest areas.

Commercial: Most cities have a commercial district. The commercial buildings are usually attached together, yet differ from each other in architectural style, building materials and size. In many commercial districts advertising signs are visually predominant and trees noticeably lacking. Most commercial districts do not appear to be visually integrated with the rest of the community.

Several planting criteria for the commercial districts can be identified. The goal of any proposed tree planting should be to unify the architecture and link the commercial district with the rest of the community. In most cases a bold, uncomplicated planting design is well suited to commercial areas. Such designs will help to unify the visually complex environment. Also, the limited available planting space between the curb and store front makes it difficult to use more complex planting schemes.

The trees selected should be open enough to allow visual access to store fronts, yet large and dense enough to provide shade for pedestrians. The height (to canopy bottom) of trees selected should be eight feet or more to allow pedestrians to walk beneath the canopy. If trees overhang the street, allow 15 feet of clearance between the street and the canopy.

Space trees close enough together to allow their canopies to overlap. This provides shade and visual continuity. The planting for Center Street in Provo, Utah, meets these criteria well and has been both a visual and financial success.

Since large and frequently unsightly parking lots are usually associated with commercial areas, provisions for screen planting must also be considered in the Forest Plan Map. A concise summary of the role of trees in commercial areas is provided by landscape architect, William Nelson: "Trees should function to separate cars from pedestrians, to provide human scale in the midst of oversized buildings, to serve as focal points, as vistas and as places to sit and to harmonize variable styles of architecture in a diverse and unorganized scene" (Nelson, 1976, p. 22).

Commercial strips: These seemingly endless collections of tawdry buildings and loud signs along the "main drag" are a recent phenomenon in medium as well as large communities in this region. Planting to unify a commercial strip is desirable but difficult because the large number of curb cuts and access drives greatly reduces the space available for planting. However, planting all available spaces with large trees will help reduce the visual clamor. Logan, Utah, has used this concept in its planting of hybrid elms along north Main Street. Even though these trees are still small, they have helped tie the strip into the rest of the community. In commercial areas it is important to coordinate tree planting with other elements of street improvement such as sign control, lighting, pedestrian access and parking.

Residential: Single-family residential areas, the most common in the region, are typically comprised of homes in a variety of architectural styles. The homes are separated from each other and set back from the street. Without trees there is little sense of continuity in a single-family, detached-home neighborhood. Here, as with the previous land use, the primary aesthetic role that tree planting can play is to visually link individual buildings into a unified scene. It is precisely this unified quality that makes older neighborhoods with mature trees so attractive in many regional communities, as illustrated in Figure 6-12. In addition, trees planted in strips parallel to the street provide some degree of privacy, separating public street space from private front yard space.

Figure 6-12. Mature Trees In an Older Neighborhood

Either formal or informal planting schemes are appropriate for single-family, detached residences. In most instances large trees, spaced so that the canopies overlap are desirable. Taller trees are also effective in shading structures set back from the street. If sidewalks parallel the planting strip, the height (to canopy bottom) of trees should be a minimum of 8 feet to accommodate pedestrian traffic. Again, 15 feet of clearance is required where branches overhang the street.

Multiple family housing, duplexes, four-plexes, town houses and apartments are becoming more common in larger communities in this area. Because these housing units have common walls, they are visually more dominant than detached homes. Multiple family units are perceived as large blocks and are strong definers of outdoor spaces. They also have associated with them sizable areas of off-street parking which is frequently adjacent to the street and highly visible.

The major forest planning concern is to integrate the larger scale of multiple family housing with the rest of the community. The planting concepts discussed above are applicable to multiple-family housing; however, plantings should include provisions to screen off-street parking.

Mobile homes remain a fast growing form of housing in the Interior Western States. Most communities have relegated mobile homes to mobile home parks. These concentrations of long, thin, metallic housing units present a unique challenge because they differ so drastically from the rest of the community. Dense plantings of medium or large trees in the planting strips will help minimize the visual contrast, reduce glare and create a shaded environment for residents.

Industrial: Industrial buildings or complexes of buildings are common to many communities in the region, agriculture-related industry being the most common in small communities. Industrial buildings are larger and visually more dominant than most other structures in the community. Large, outdoor storage areas, service yards and parking lots frequently accompany industrial development.

The challenge in tree planting for industrial areas is to integrate the industrial architecture with the rest of the community. This does not imply hiding it behind a wall of living green, but rather making the industry visually and functionally a part of the community. The scale of any proposed planting adjacent to industrial development needs to be bold so that it matches the industrial architecture and related outdoor areas. Trees should be large and closely spaced to emphasize, where possible, the attractive architectural features of the complex. Frequently there is a need to screen the less attractive aspects of some industrial buildings and to plant for noise abatement. These needs should also be considered in the Forest Plan Map. Many industrial sites afford the unique opportunity of planting massive forests which can serve as windbreaks, woodlots, noise buffers, and wildlife habitat.

Institutional: In this region schools, government buildings, and churches frequently have adjacent open spaces. A church or government building is commonly associated with the town square. The town square is often

Figure 6-13. A Planting for Recreation and Wildlife

centrally located and faces commercial development on one or more sides. It is typically the visual and spatial focus of the community.

The visual importance of the town square suggests that it should be given special consideration in the Forest Plan Map. Formal planting arrangements and large trees effectively emphasize the importance of institutional sites. The Shade Tree and Beautification Commission of Wellsville, Utah, for example, has decided to plant large trees in a formal pattern around the town square on both sides of the street. This bold planting statement will clearly identify the importance of the square in the community.

Town squares are frequently adjacent to at least one of the community's major streets. This affords additional tree planting opportunities. Combining bold planting around the square with a similar treatment for major streets forges a visual link between peripheral areas of town and its heart, the town square.

Large trees are appropriate for both significant institutional sites and major roadways even though they may require special care to protect overhead utilities. The cost of "tunneling" utility wires through tree canopies in these visually critical places is, in our opinion, justified.

Special forest areas: The community forest when viewed in the broader perspective can itself become a significant land use. It is perhaps time for us to begin considering areas in the community for woodlots, municipal tree nurseries, windbreaks, and wildlife habitat. The possibility of acquiring easements for these planting purposes should be discussed when developing the forest plan. However, more detailed site investigations will be necessary to determine the best location in terms of need, location, land availability and growing conditions.

12. **Involve community residents and department heads from other branches of city government in developing and reviewing the Community Forest Plan Map.** The comments, criticism and creative ideas of community residents must be integrated into the planning process at the on. Public input will lead not only to a better plan but, also, and more importantly, to a plan which will succeed because it has public support.

Adhering to the principles discussed above will help those involved in the forest planning process to achieve a successful planting pattern. It must be pointed out, however, that there is no recipe which can be followed to develop a successful planting pattern. It cannot be assumed that if principles one through twelve are applied, a planting pattern acceptable to everyone will be achieved. Invariably, conflicts will arise as to how to best plant a particular street or park. Functional concerns, for example, may require one type of solution; visual and spatial considerations another. Opinions will vary. The person responsible for tree care, the city engineer, the utility company representative, or neighborhood residents may have differing ideas about what constitutes appropriate tree planting. But the nature of creative problem solving is dynamic. The Shade Tree Commission must encourage and incorporate input from citizens at large as well as professionals to develop a creative Forest Plan that will be supported by the community because it reflects community values.

Tree-Type Categories

Using the design guidelines just described, it is now possible to develop a list of Tree-Type Categories for your community. A Tree-Type Category defines the relative tree size and pattern for new plantings. **The Forest Plan Map depicts the location of each Tree-Type category throughout the community.**

Planting pattern and tree size are used to derive the Tree-Type Categories. Table 6-1 illustrates sixteen possible Tree-Type Categories.

Table 6-1. Sixteen Tree-Type Categories.

	Planting Pattern			
Tree Size	Formal	Informal	Combination	Wildlife
Large	Formal Large	Informal Large	Combination Large	Wildlife Large
Medium	Formal Medium	Informal Medium	Combination Medium	Wildlife Medium
Small	Formal Small	Informal Small	Combination Small	Wildlife Small
Mixed	Formal Mixed	Informal Mixed	Combination Mixed	Wildlife Mixed

The number of Tree-Type Categories selected will vary with each community. A small community with a grid street pattern, no overhead wires and no narrow planting strips may opt to use only the Formal Large and Formal Medium categories to articulate major and minor streets. As the community pattern becomes more complex and constraints on tree size increase, a larger number of Tree-Type Categories will be needed.

Drawing the Community Forest Plan Map

The easiest way to select and locate Tree-Type Categories for your community is to work directly over the Community Pattern Inventory Composite. This is done by placing a sheet of tracing paper over the Composite drawing. Begin by selecting an appropriate planting pattern: formal, informal, combination, or wildlife. Mark the borders of all the major streets that are to be planted formally with a broad lines of one color. Use broad, squiggly lines of another color to define informal planting patterns for other streets, parks, and public open spaces. With a third color, illustrate the locations of combination formal and informal planting patterns with straight broad broken and with a fourth color to show wildlife patterns by a broad irregular line. The broad lines drawn to indicate the type of planting pattern should be drawn on either side of the streets so as to enframe them and around the edge of parks and open spaces to indicate the type of pattern to be planted within. See Figure 6-15 for an example of Community Forest Plan graphics.

Next determine the size of trees to be planted. This is shown by varying the types of fine black lines drawn through the broad colored lines used to describe the planting patterns. Indicate large trees with fine black vertical lines, medium trees with fine black horizontal lines, and small trees with black stipples. Show mixed tree sizes with vertical and horizontal cross-hatching. These symbols are illustrated for each Tree-Type Category in Figure 6-14.

After completing the first study, discuss and critique it using previously stated goals and objectives as evaluation criteria. Changes and alternative schemes can be explored quickly on tracing paper overlays. The process continues until an agreed upon design is achieved. Once consensus is reached, transcribe the design onto a clean base map that will become the final Forest Plan Map. Figure 6-15 illustrates the final Community Forest Plan Map for Grove City, Nebraska. It was developed from the Community Pattern Composite (See Figure 5-4). Seven Tree-Type Categories are indicated.

Large Formal plantings are designated for the major roads where no overhead wires, narrow planting strips, etc. constrain tree selection. A **Formal Medium** tree-type is used along the remainder of the gridded streets except where overhead wires exist, in which case the **Formal Small** tree-type is used. **Informal Large** and **Wildlife Mixed** plantings are shown around the churches, schools, park and industrial facility.

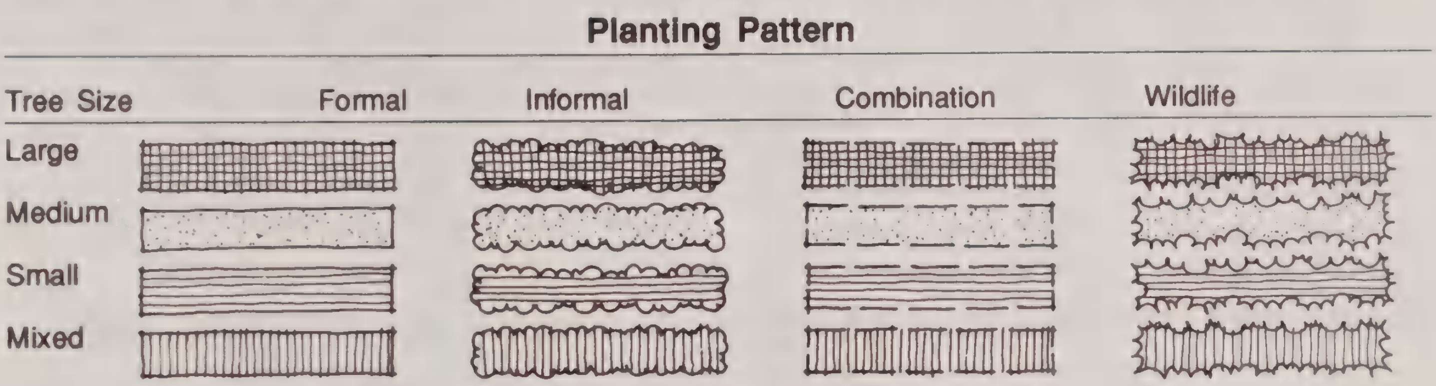

Figure 6-14. Symbols Used to Illustrate Tree-Type Categories

The **Informal Mixed** and **Wildlife Mix** tree-type is suitable along the curvilinear roads in the new subdivision. This type will blend with the existing juniper forest that penetrates into the area. It is also shown around special places such as the churches, schools and parks. The large, open nature of these spaces and nearby riparian vegetation dictate the use of an informal mixed tree-type in these areas. In transition zones, where riparian vegetation meets major streets, the **Combination Mixed and Wildlife Mixed** tree-type is preferred. In this case, the transition from an informal to formal pattern is achieved using a variety of tree sizes. Areas where future **Windbreaks** will be planted are shown and designated as special Tree-Type Category. Appendix E consists of a tabloid which contains the Wellsville Community Forest Plan Map and a description of criteria used to select and locate appropriate Tree-Type Categories.

At this point, it is important to note that the Forest Plan Map does not recommend specific tree

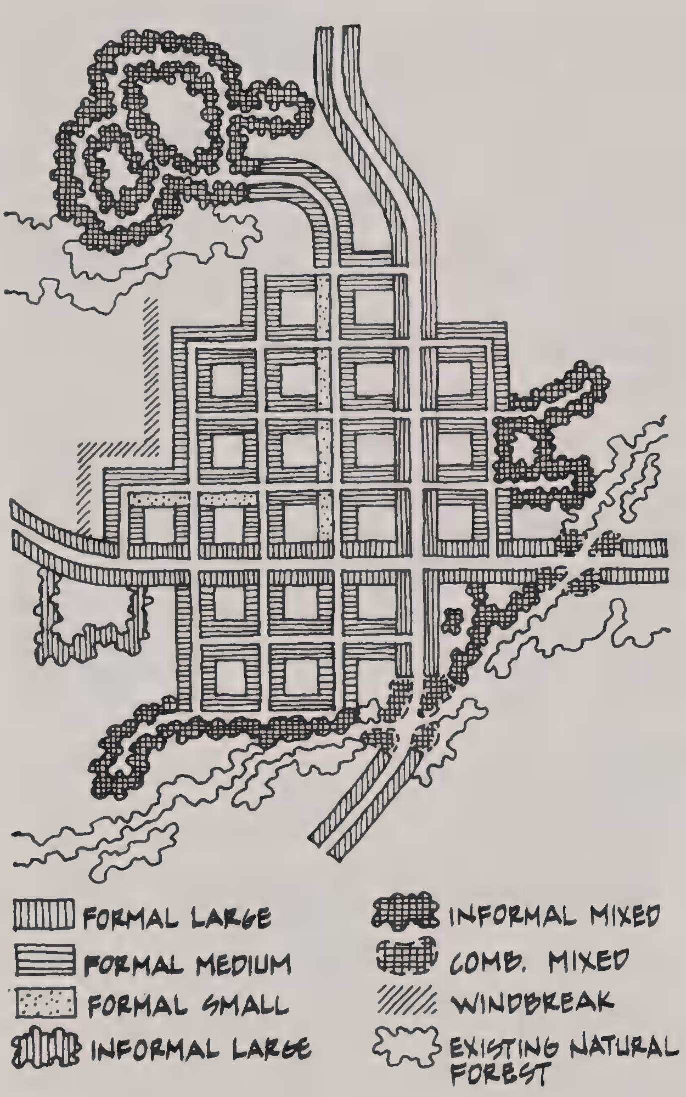

Figure 6-15. An Example of Community Forest Plan Map

species for planting. In our opinion, **specific tree species should not be designated for planting until a thorough project site evaluation has been completed** (See Chapter VIII). If the growing conditions and other pertinent factors are not understood, you are not yet ready to select trees. The Forest Plan Map assures you that the new plantings will have a high degree of visual and spatial order. At the same time, it provides more flexibility and freedom in tree selection than does a plan that specifies the type of species to be planted on each street and in public parks. The Community Forest Plan Map promotes individual expression through tree selection within a set of guidelines designed to enhance the community's visual and spatial attractiveness and minimize public tree care costs due to selecting inappropriate trees that may require extensive pruning or cause damage to sidewalks, curbs, etc.

Tree Lists for Tree-Type Categories

It is desirable to list tree species that qualify for each Tree-Type Category. This provides the Shade Tree Commission, the person responsible for tree care, or those local citizens preparing to plant trees in compliance with the Forest Plan Map with a convenient list of trees from which to choose. If, for example, the Forest Plan Map specifies a Formal Large tree-type along a street, then every tree species listed under that tree-type would have a symmetrical, formal character and reach at least 40' at maturity. Persons living on the street would then conduct a project site evaluation to select the most appropriate plant from the total list of trees in the Formal Large Tree-Type Category. Figure 6-16 contains a list of tree species and recommended spacings for the four Tree-Type Categories used in the Wellsville Community Forest Plan Map. The list was included in the Forest Plan Report and is periodically reviewed and updated by the Wellsville Shade Tree and Beautification Committee. The following criteria were used to select these trees: size, tree character, hardiness, and low maintenance characteristics. Chapter IX, Tree Selection and Planting, contains more information on how to derive a list of tree species for each Tree-Type Category. Once the Tree List is compiled, it can be located in the legend of the Forest Plan Map or included in the Forest Plan Report.

Community Forest Plan Report

The second product in the Forest Plan is a report. The report should include three sections:

Documentation of Goals and Objectives, Ordinances and Policies

The goals and objectives should have been determined when the Community Forestry Program was established. They should be restated as a matter of record in the Community Forest Plan Report. Although the ordinance and policies are often completed after the Forest Plan Map, they should be appended to the report as a matter of public record.

Documentation of Decision Criteria

The criteria used to make the planting pattern decisions illustrated on the Community Forest Plan Map should be recorded in the report. The notes of the Shade Tree Commission secretary can provide the necessary information. This aspect of the report will become an important reference in future years as membership on the Shade Tree Commission changes.

Tree Species and Spacings For Each Tree Type Category

Formal Large Trees

BOTANICAL NAME	COMMON NAME	SPACING (In Feet)
Acer platanoides	Norway Maple	35-45
Acer rubrum	Red Maple	30-40
Celtis occidentalis	Common Hackberry	30-40
Fraxinus americana	White Ash	35-45
Fraxinus excelsior	European Ash	30-40
Fraxinus pennsylvanica lanceolata	Green Ash	35-45
Ginkgo biloba	Maidenhair Tree (Male)	25-35
Gleditsia triacanthos c.v.	Honeylocust	35-45
Gymnocladus dioicus	Kentucky Coffee Tree	25-35
Platanus acerifolia	London Plane Tree	40-50
Tilia species	Linden species	30-40
Ulmus americana	American Elm	40-50
Ulmus parvifolia	Littleleaf Elm	30-40

Formal Medium Trees

BOTANICAL NAME	COMMON NAME	SPACING (In Feet)
Acer campestre	Hedge Maple	20-30
Koelreuteria paniculata	Goldenrain Tree	20-30
Morus alba	White Mulberry "fruitless var."	25-35
Sophora japonica	Japanese Pagoda Tree	30-40
Syringa amurensis japonica	Japanese Tree Lilac	20-30

Formal Small Trees

BOTANICAL NAME	COMMON NAME	SPACING (In Feet)
Acer ginnala	Amur Maple	15-25
Cercis canadensis	Eastern Redbud	15-25
Crataegus lavallei	Carriere Hawthorn	20-30
Crataegus oxyacantha	English Hawthorn	20-30
Crataegus phaenopyrum	Washington Hawthorn	20-30
Malus species	Crabapple species	20-30
Prunus blireiana "Newport"	Newport Flowering Plum	15-25
Prunus cerasifera	Purple-Leaf Plum	15-25
Prunus serrulata	Japanese Flowering Cherry	15-25
Pyrus calleryana	Bradford Flowering Pear	15-25

Informal Mixed Trees

BOTANICAL NAMES	COMMON NAME	SPACING (In Feet)
Betula occidentalis	River Birch	15-25
Crataegus rivularis	River Hawthorn	15-25
Elaeagnus angustifolia	Russian Olive	25-35
Populus species	Poplar species	varies
Salix species	Willow species	varies

Figure 6-16. Tree-Type Categories and Tree Lists From Wellsville, Utah

Program Priorities

The Community Forest Plan Map provides general guidelines for the selection and arrangement of trees on public lands. However, before new plantings are begun, the Shade Tree Commission should determine what existing trees need maintenance work, which dead or dying ones need to be removed, and where new trees can be planted. These needs should be prioritized. Results from the Tree Inventory provide detailed information for this analysis. The purpose of establishing program priorities is to provide an orderly plan for the current and long-range management of the community forest, a plan consistent with the existing and projected tree care budget. It is important that program priorities be listed in the Community Forest Plan Report. A closer look at factors to consider when establishing program priorities follows.

Maintenance. The systematic maintenance of existing trees is important for three reasons: safety, savings and aesthetics. The prompt and routine care of trees that pose a potential hazard to people and property is the highest priority in any program. Trees which are not maintained have a shorter useful lifespan than those regularly and properly cared for. Proper maintenance can minimize removal and replanting costs. "Street tree managers should pay particular attention to the survival of their recently planted trees in determining replacement needs and should emphasize good care of young trees as the most effective means of holding future replacement needs to a reasonable level" (Richards, 1979). The final reason for a systematic maintenance program is to provide an aesthetically pleasing environment. Trees regularly pruned and treated for insect or disease problems enhance the attractiveness of a community.

Information from the Tree Inventory must be analyzed to determine what proportion of the tree care budget should be allocated to maintenance as opposed to tree removal and planting. The amount of maintenance required can be estimated by finding the percentage of trees in poor condition or in need of maintenance. Once the number of trees needing each type of maintenance action is known, the total expenditure required to improve the condition of the entire community forest can be estimated. This can be done by establishing an average cost for each maintenance action and multiplying that cost by the number of trees needing that maintenance action. Totaling these estimates will provide the cost of projected maintenance. In most cases, limited budgets will require that the maintenance actions needed to maintain the community forest be phased over several years. It then becomes necessary to prioritize the maintenance program. The Shade Tree Commission and persons responsible for tree care should decide which maintenance needs are most pressing and which can be delayed with minimal impact on the overall safety and condition of the community forest. Eliminating hazardous conditions is the highest priority. Two high priority maintenance actions are treating unhealthy young trees and new transplants. However, if an insect or disease infestation is beginning to threaten a number of trees and could potentially decimate a sizable portion of the community forest, the Commission may elect to postpone other maintenance so that more funds will be available to deal with this urgent problem. In all cases it is necessary to consider the following questions when prioritizing maintenance actions:

1. How will the benefit of a given maintenance action compare with the cost as a function of plant age and condition? (Pruning and fertilizing a weak, old tree may be more expensive in the long run than removing it and replacing it with a young tree.)

2. What can be expected to happen if a maintenance action is postponed? (Will the tree die, and if so when? Will other trees be affected and to what extent? How does this translate into future maintenance costs?)

Removal. The removal of dead or dying trees is an item the Shade Tree Commission and tree care manager should consider when developing program priorities. Tree removal is important for safety and aesthetic reasons. Weak and dead trees are especially subject to storm damage, and thus pose a threat to people or property. In addition, they diminish the attractiveness of a community.

Removal costs can be estimated by examining the tree size (DBH). Large trees are generally more expensive to remove than small trees. However, tree location is also a primary concern. The proximity of overhead wires and buildings, as well as planting strip characteristics are important factors. If the Tree Inventory has been computerized, these important variables can be used to improve tree removal cost estimates. The costs associated with disposal of the wood waste should also be included. Some communities may sell the wood to offset removal and clean-up costs.

The removal of dead trees should be a high priority item in the program. If a community has numerous trees to be removed, it may be necessary to allocate a percentage of the total tree care budget to tree removal for a number of years. Trees that pose the greatest hazard to people and property should be removed as soon as possible.

Planting. New plantings are a high priority item in most community forestry programs. Trees are frequently planted where vacant planting spots exist. A tree may not have been planted at the spot or it may have been previously removed. In the older parts of some communities, most trees are mature and declining in vigor. To insure the continuation of the community forest, young trees should be intermixed with old trees. Consider as a program goal, planting as many trees as are removed each year. This is necessary to maintain a stable tree population. If more trees are desired, planting must exceed removal. In some cases it may be necessary to remove or prune old trees to provide a younger tree with the light and room it needs to grow vigorously. This "harvesting" of older trees may be unpopular with some local citizens, but it is essential to the perpetuation and overall health of the community forest. A good public relations campaign can help citizens understand that trees have a useful lifespan and that when trees exceed that lifespan, they must be removed and a new tree planted in their place. Tree plantings are also popular events that can generate public involvement and support for the program. New plantings in highly visible areas of the community let the public know that the Shade Tree Commission and persons responsible for tree care are promoting activities that beautify the city and promote the public welfare.

The number, size and location of new trees needed in the community can be determined from the tree inventory, if vacant planting sites are noted. The number of removals during the specified period should be added; as these will become vacant planting sites. Once the total number of new plants needed is known, the approximate cost of all new plantings can be determined. This is done by assigning an average purchase price for each tree (which depends upon species and caliper) and the planting cost per tree (which depends upon materials, equipment and labor costs). The result of this calculation is the approximate amount of money required to "reforest" the community.

If the number and costs of new and replacement plantings is high or if the need for maintenance and removal is given a higher priority than new plantings, as is often the case, the Commission may identify and prioritize new planting projects. For example, funds may be allocated for one new planting project a year for five years. Prioritization of planting projects will depend upon the specific needs of the community. In Wellsville, Utah, the Shade Tree and Beautification Commission identified the Town Square and nearby recreational area as the highest priority places for planting. Seven old trees were removed, and forty ornamental and shade trees were planted as an Arbor Day project. In future years, other areas of the city will be attended to and appropriately planted.

Because funds available for tree care are usually limited, the Shade Tree Commission must carefully evaluate the condition of the community forest and then determine how monies can be allocated to best advantage. **A Program Priorities Plan should designate funds needed for tree maintenance, removal and new planting projects within a five to ten-year time frame.** A systematic maintenance program should be the backbone of the plan because proper maintenance will reduce the funds needed for tree removal and replacement plantings.

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VII. TREE ORDINANCE AND POLICY

- Why Ordinances?
  - Establishing a Program
  - Identifying Public and Municipal Responsibilities
  - Regulating Arboricultural Practices
  - Alternatives to Ordinances
- Drafting an Ordinance
  - Obtaining Existing Legislation
  - Identifying the Players
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- Ordinance Sections
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TREE ORDINANCE AND POLICY

This chapter is designed to assist a community to prepare a shade tree ordinance and to get the ordinance approved. It does not contain a "fill in the blank" ordinance. Each community operates under different policies, needs, and values, and many communities already have some legislation that regulates trees and their management. State statutes differ in the leeway they allow local governments. The ordinance should reflect this individuality. This chapter offers ideas that could be incorporated in an ordinance. By carefully considering the needs of the community, those responsible can use this information as they develop a comprehensive shade tree ordinance suitable for their community.

Throughout this chapter, for simplicity, the title "city forester" is used to identify the person responsible for trees. Few communities can afford the luxury of a professionally trained urban forester. Many communities have very effective private citizens or conscientious city employees serving as city foresters. If this title does not seem appropriate for the position as it is perceived in your community, by all means use a more acceptable substitute.

This chapter also assumes that the ordinance is being prepared for a local community, referred to, again for simplicity, as "the city." Much of the content also applies to other jurisdictions, such as counties. Feel free to make any necessary changes in your mind.

Why Ordinances?

It's in the urban forestry bible as the second commandment "Thou shalt have an ordinance." At some time during the ordinance process, everyone asks "Why do we need an ordinance?" Unfortunately, many involved ask this question after the City Council has just recommended lengthy revision – after the ordinance committee has spent three months getting to that point! If this question is answered prior to starting the ordinance process and kept firmly in mind during the process, the ordinance process will flow much more smoothly.

Ordinances are often initiated shortly after a program is established. These ordinances give the program the legal standing it will need as it emerges. The visibility of the urban forestry program can be increased by the ordinance. An ordinance can provide program direction. **It establishes the program** independent of political variation, budget restrictions, or public opinion. The statement of purpose in the ordinance becomes a legal charge for the program. Many ordinances assign responsibility for program direction to the city forester, the shade tree commission or some other group. The ordinance establishes authority for accomplishing tasks. An effective ordinance can stabilize the fledgling urban forestry program, providing a formal framework for interaction with other departments. The ordinance can be used to establish the shade tree commission by giving it legal standing. The ordinance often states the method of making commission appointments as well as the duties, terms and compensation for members. The relationship with the arborist and/or city forester is often specified. The ordinance sets the shade tree commission's mode of operation and its degree of independence.

The ordinance often provides a framework for dealing with the public in day-to-day maintenance, as well as pest induced crises. Some ordinances go so far as to establish program funding. The ordinance can clearly establish the responsibilities of the public and the city, and allow the city to manage problems and, much less frequently, opportunities on private property. Ordinances provide rules for dealing with public access, notice, nuisances, and failure to comply. The ordinances should clearly state what the city will do on private property, and under what circumstances.

Establishing responsibilities of the public for tree care is another function of ordinances. They can clearly define what care the public is to provide to which trees and what the standards of that care should be. Some ordinances have provisions for regulating "volunteer" or cosmetic work provided by homeowners. This is often done by issuing a permit.

For many communities, **the ordinance provides an opportunity to regulate arboricultural practices** (such as planting, trimming, removal, and selecting suitable species) of both the city and of private contractors working for and in the city. Cities can require that, for example, proper pruning practices be used on city trees, and if the contractor fails to comply, he can be barred from bidding on future city contracts. Some cities have used the ordinance to require that all private contractors operating in the city carry a specified amount of liability insurance. Cities can license contractors and require continuing education of those contractors. In many cases, this causes the less reputable contractors to do business elsewhere. Licensing procedures and the grounds for revoking licenses can also be included.

Hager *et al.* (1980) found that homeowner initiative in tree planting was discouraged in communities with strong ordinances. These communities had a list of acceptable species, required permits for planting, and adhered to planting plans. Citizens felt that the city had made the decision on what to plant on "their" planting strip for them. These authors also point out that to prohibit planting large, fast-growing trees conflicts with the homeowner's desire to have shade now. Perhaps better public relations could have prevented such resentment. Without excellent communication many well founded ideas within an ordinance can render it very unpopular.

Many urban forestry programs have elaborate ordinances, for a one-man program. Do not establish an ordinance which incorporates strict requirements that the city (or you!) cannot enforce. Develop an ordinance that meets the city's ability to manage the city's resource. It is easy to become heavy handed, requiring John Q. Public to do this or that and threatening him or her with fines or jail if he does not. Any city forester or member of a shade tree commission who does this will not be accepted by the community. The ordinance gives the program an opportunity to provide incentives for compliance as well as to say you must do this! Incentives can turn an unwilling participant into an active advocate of the program. As a program manager, provide incentives whenever possible, then always try to persuade the public to comply, and lastly attempt to negotiate disagreements. Only if these avenues fail, should the city resort to prosecution.

Some communities, particularly those with smaller populations, avoid the ordinance issue altogether by adopting a permit system which requires that anyone wishing to perform some aspect of tree care must first secure a permit. While such a system does avoid the legal process of adopting an ordinance, it also leads to a "program" which may be less desirable. The program, and the shade tree commission often lacks legal status defined by ordinance. The program may be easily dissolved during times of financial stress or political change. Furthermore, both the permits and the ordinance require that tree care be performed properly and with official approval of the City. If violations occur, enforcement may be needed. It is probably much easier to enforce an ordinance than a permit system. Nevertheless, many communities still operate with permit systems, so there must be some merit to those systems.

Considering the options and the desired policy prior to beginning the ordinance process will greatly aid the group to maintain focus and attain its goals in a reasonable amount of time. Write your ideas on paper. This list can serve as a starting point for determining the goals and purpose of the ordinance. Keep in mind, however, that the ordinance is only a means to an end. Ordinances set standards, but they do not ensure the success of an urban forestry program . . . **Tree ordinances must reflect the values of the community and be implemented consistently** (after Morgan 1987).

Drafting an Ordinance

The first step in drafting an urban forestry ordinance is to **obtain all existing city legislation** that pertains to trees. This information may be obtained from the city manager or the city attorney. These ordinances will help you to determine what is covered under existing ordinances and what is needed to bring tree care regulation to the desired level. Contact the state urban forestry coordinator for state laws that concern trees, as well as for ordinances from other communities. These other ordinances can be helpful in determining what could be done, and how to do it. **Do not copy them; develop an ordinance that meets <u>your</u> community's needs.**

With this information in hand, one should now consider the politics of getting the ordinance drafted and passed. **Who needs to be involved to insure passage?** There will be resistance to a new ordinance, because many citizens believe that less government is better. "Trees have done quite well for many years without an ordinance" they may say. "Why do we need one now and how do we pay for it?" Be prepared to deal with these opinions and questions. They are valid. One way to head these arguments off is to identify someone in the community who is influential and is partial to

trees. In almost every community there is someone who commands respect, whose ideas are listened to. If you can identify such a person or persons, and get them on your side, the ordinance will proceed much more smoothly. Perhaps a friendly city councilman or the city attorney can help you identify these people. Ask them if they would be willing to donate time to serve on a committee to develop an urban forestry ordinance.

This committee could be the precursor to the shade tree commission. Representatives on the committee should include someone from the city's park board, street department, planning department and, as Sievert (1985) recommends, the local utility company or department(s). These people all must work with the trees. Their input is essential to the success of the ordinance, and they can be extremely helpful. They will often bring totally different perspectives about trees to the group, resulting in a more balanced ordinance. Approach the city attorney to determine if he or she would like to be involved at this time or would prefer to work with drafts prepared by the group. Consider involving citizens representing local organizations (garden clubs, environmental groups such as Audubon and Sierra Club, and local tree contractors). All of these people have something to gain from a good ordinance, and something to lose if they are not part of the effort. An ordinance developed by such a large, diverse group can be well balanced, and will have a much better chance of passage. The city council may perceive an ordinance prepared by the group as more representative of varying interests than an ordinance prepared by the city forester alone.

Reflecting on the list of needs, options and desired policies determined earlier, **draft a list of the necessary provisions** in plain English. It would be best to send these to the group for their inspection prior to the first meeting. At the meeting, there will no doubt be some discussion of the merits of many items. Be patient. Listen. These individuals are not attacking you or your work. They are trying to do what they think best for the trees. Be flexible and willing to compromise. If you react negatively to suggestions and criticism, you will offend people, and could lose their support. Perhaps the best strategy is to let all on the group be heard. You may even have to probe some of the quieter individuals in the group. Their opinion is worth just as much as that of the loudest individual. You will win their support by giving them a chance to express their views and listening to them. Try to lead the group to a consensus and record that consensus in writing. It is often helpful to have a secretary or someone not involved in developing the ordinance to concentrate on recording the proceedings. As the group agrees on the content, draft these parts of the ordinance and get it back to them for their review.

When you have what you think is a complete draft, pass it on to the city attorney to begin drafting the formal ordinance. You may wish to meet with the attorney to be certain the group's intentions are clearly understood. When the city attorney has prepared a draft, it should be sent to the committee members prior to the next meeting. Encourage them to read it carefully to make sure that their intent is expressed in the ordinance. Ask the city attorney to meet with the group from this time on to hear the group's intentions so that the draft ordinance may be revised appropriately. Do not lose heart at this stage. There can and will likely be many drafts as the ordinance is tuned to meet the needs specified by the committee and to conform with legal protocol. For example, Salt Lake City prepared 14 drafts of its ordinance before it was approved. Smaller communities will probably go through fewer iterations, but it is almost certain that the first draft will be revised.

At some point the group will feel confident that the time has come to **present the ordinance to the mayor and the city council.** Each community may have a different procedure for doing so. Consider asking the council and mayor for an opportunity outside a council meeting to discuss the ordinance with the committee. This can be a great opportunity to educate them. Newspaper articles detailing the proposed ordinance and the process used to develop it should be prepared to educate the public.

The ordinance must be read three times at city council meetings before being voted upon. The committee should be represented at each reading, because the public may inquire or express some concerns. The ordinance may be read once or twice before being returned to the group for changes and revisions. It is clearly important that the group continue to educate the council and the public about the benefits provided by the ordinance. Keep in mind, though, that the ordinance committee has no standing. Even though you believe you are correct, the council will determine the fate of the ordinance. Almost any ordinance is better than no ordinance. If the council is firm on several points, make the necessary changes. If management proves difficult over the course of time, you can return to the council with a proposed amendment. After approval, the ordinance must be published, and it will then take effect after 30 days.

Ordinance Sections

The paragraphs below represent sections which might be included in an ordinance. Some

are necessary, others are optional. These topics and some of the tradeoffs of incorporating them are discussed to provide ideas for consideration as the ordinance is developed. Keep in mind the needs and attitudes of the community as sections are considered. Talk to urban foresters in nearby communities and get their recommendations. Learn from their experiences, **but build your own ordinance!**

Title. The ordinance should have a concise title that reflects its purpose.

Purpose. The first part of the ordinance is the purpose. This is often a policy statement to the effect that the urban forest provides benefits to all and that the city is concerned about maintaining these benefits. The purpose often states that the ordinance will protect and promote the public health and safety by regulating tree management activities. While this is often the initial section of the ordinance, it may be best to wait until the main body of the ordinance is completed before writing the purpose.

Definitions. This section defines the terms used in the ordinance, such as city, city property, public tree or shrub, city forester, or public right-of-way, etc. This section will probably be assembled by the city attorney. Other definitions to consider: Shade tree commission (or urban forestry board, or whatever this body is called), hazard tree, pest-infested tree, public place, property line, tree lawn, planting strip, and parking strip.

Shade Tree Commission. This section creates the shade tree commission, defines its composition, and charges it with responsibilities. This group may be given one of many names (shade tree advisory board, committee, street tree board), or its function may be assigned to the parks board or a subgroup thereof. We use the term shade tree commission throughout this manual, but we refer to that body which is concerned with the trees. The commission consists of a group of citizens concerned about trees. The ordinance will designate the duration of the appointment and procedures for making appointments and filling vacancies. Department heads of streets, utilities, and parks and recreation may be named as members. A clause may be inserted allowing the appointment of advisory *protem* members as needed for specific problems. For example, this would allow the extension entomologist to be appointed to the board when gypsy moth is discovered in the community. Compensation for services may be established here. The ordinance may specify the frequency of commission meetings. Perhaps most important, the ordinance may spell out the relationship of the shade tree commission to the city forester and to the mayor and city council. This is a prime opportunity for the city forester to establish a close working relationship with the shade tree commission.

The shade tree commission may receive direction from the ordinance. Among the responsibilities that may be assigned to the shade tree commission are:

Assisting the city forester or person responsible for tree care in developing a comprehensive urban forest plan

Developing arboricultural regulations concerning tree planting, maintenance and removal of trees on city property.

Recommending requirements for licensing arborists.

Recommending to the mayor/council policies regarding trees and other vegetation on city property.

Recommending to the mayor/council policies regarding trees and other vegetation on private property where open space and/or landscaping is required as a condition for development. This is an excellent opportunity for requiring city forester approval of all planting plans in new development, which can ensure the establishment of "good" trees, thus preventing many future tree problems

Assisting the city forester in promoting landscape installation and maintenance on private property by providing information to the public through educational campaigns, published materials and other opportunities.

Identifying potential landscaping projects that will further improve the community forest.

Recommending policies to identify, publicize and preserve historic and notable trees on both public and private property.

Assisting the City Forester in planning and implementing Arbor Day celebrations and other activities.

Encouraging and soliciting donations and other funding for the urban forestry program or for special projects.

Planning and reviewing urban forestry program budget requests. Some shade tree commissions are authorized to receive gifts and bequests.

Hearing appeals of decisions made by the city forester. The commission may be given authority to overturn the decision, or that authority may be assigned to the mayor or city council.

These are some of the responsibilities that may be assigned to the shade tree commission. Feel free to exclude those that are inappropriate and to include others needed in your situation.

City Forester. The ordinance may establish the position of City Forester, urban forester, tree care manager or municipal arborist, and some have gone so far as to establish how the this person is to be chosen. What this person is called is unimportant, as long as he or she has ultimate responsibility for trees and the community forestry program. This section should identify where in the hierarchy this person is assigned, and how this person will interact with other departments responsible for managing city parks, streets, or utilities. The forester's duties may be spelled out, in a very general manner.

Authority of the City Forester. This separate section gives the city forester authority to perform certain duties on public and private property. For example, the city forester may be charged with regulating the planning, planting, maintenance and removal of trees and shrubs on city property. The ordinance may specify whether and how the city forester is to notify adjacent property owners affected by such management. Another section dealing with trees on private property may authorize the city forester to prune or remove trees on private property which interfere with power lines, sidewalks, curb and gutter, visibility, or which pose a hazard to the general public. If such a section is included, procedures for providing notice to tree owners must be established. This section, or a special section, may authorize the city forester to manage pest infested trees on private property. Such a clause is essential when a pest infestation has the potential to become epidemic, such as Dutch elm disease and gypsy moth. A procedure may be set forth allowing the city forester to notify the property owner, to cite him for noncompliance, and – if the property owner does not complete the work within specified time limits – to authorize the work to be done by the city or a contractor and to collect the cost of that work from the homeowner. This is probably a good clause to have in an ordinance, even if it is never used.

The city forester is often charged with promulgating rules and regulations for the daily operation of the urban forestry program. The ordinance may place the power to approve and/or adopt these rules and regulations in the hands of the shade tree commission, the director of parks and recreation, the city council, or the mayor.

In some communities, certain properties are exempted from the authority of the city forester. Such areas might include parks, cemeteries, public property under the control of some other city department, nurseries and botanical gardens, and state schools and universities.

The City Forester's Enforcement Duty. This section assigns to the city forester or a representative the duty of enforcing the ordinance and regulations adopted by the shade tree commission. Usually, this section provides a procedure for notifying the landowner, and a different section describes the consequences of non-compliance with ordinance requirements.

Permits. Many communities require the public and/or utility companies to obtain a permit before planting, trimming or removing any tree on public right-of-ways. The permit allows the city to regulate these practices, to use permit information to check the work and to update the tree inventory, but perhaps the best function of the permit is to provide a forum for educating citizens before they initiate such tasks. Information on tree selection or proper pruning can be provided with the permit in order to improve the quality of work done by the public. Most cities exempt city crews and

contractors working on city contracts from the permit requirements. In some communities, the permit expires after 30 days, limiting the time for the work to be done. Often, the permits require that the city be notified within five days of completion of the work. This can help the city forester schedule site inspections.

Permits usually request information about the address, the type of work to be done, the number and species of trees to be treated, and information about the site, eg. width of planting strip, presence of overhead wires or other utilities, and proximity to street intersections. Much of this information may be verified by data from the inventory, if the inventory is computerized. When the work is completed, the inventory may be updated from the permit information. The permit will often require that all debris be removed from the site.

Permits are usually required before utility companies may work in trees. If this is the case, some provision must also be made for excepting emergency work from the permit requirement.

There is a negative side to permits: Who issues them? In some communities, the demand for permits can occupy substantial staff time. Whose? The city forester cannot be available all the time, so some other city employee must be available to the public. If the city forester has no staff of his or her own, the supervisor of the person writing the permits may object. Some communities require that the permit be obtained, and/or that the city forester inspect before the work is started. There are times during the year when prior inspection may not be possible within a reasonable amount of time. The permit holder; frustrated, often begins the work. Delicate negotiation is often required to maintain this individual's support for the program. Handling work done without a permit is a common, but difficult issue. For example, in Ogden, Utah, it is estimated that only 4% of the work done by the public is done with a permit. If hands are slapped too hard, animosity develops between the urban forester and the public. Too much tolerance, and the permit system becomes meaningless. Before incorporating a tree-work permit system in the ordinance, consider its benefits and costs (including enforcement problems) in relation to the overall tree policy.

Pest Control Programs. Many ordinances are initiated to provide the community the authority to implement a pest control program. Usually, it is tree-threatening pests, such as Dutch elm disease or gypsy moth, which are the impetus for the program. These sections establish control zones - areas of the community where the disease can and will be actively managed. The objective of the management is then identified. For example, with Dutch elm disease, any dead or dying elm tree with bark intact is declared a nuisance or a hazardous condition. The ordinance then authorizes inspections of public and private property. Many communities require that notice be given before entering private property. This can greatly hamper the inspection process. A better suggestion is to require that notice be published in the official community newspaper. While this is legal notice, homeowners do not read the public notice section. This is a problem. Its solution provides a wonderful public relations opportunity: to prepare an article about what the community is doing to combat the pest. Most newspapers are starving for good, local information. Develop a good relationship with the local editor or garden editor. Then anything you wish to publish will be welcomed, and the citizens will get the word.

The ordinance will specify the notice to be given and the procedure for serving that notice. Notice written by the pest inspector will usually suffice. The notice will often contain instructions for the homeowner to abate the nuisance. While written notice is required, it is best if the pest inspector can talk with the homeowner, and explain (**educate**) to him or her the condition and the remedy. If this requires removing the tree, it can be very expensive. Many times, the homeowner sees only the green parts of the tree — not the pest and may not recognize the need to remove it. Personal contact, or at least written notice with some informational literature about the pest, is needed to ensure homeowner cooperation. If you have done a good job of public relations, most people will cooperate; however, there are always a few who will resist. The ordinance should outline a procedure for public notice, appeal, and as a final resort, abatement of the hazard by the city forester. Procedures should be stated for billing the homeowner and for collecting the unpaid bills. This often involves a special assessment, which can be paid with the taxes, but this practice creates a mess for the homeowner. It is best to have these clauses in the ordinance, so that tree-threatening pests may be controlled. It is also best to avoid using them, negotiation being the preferred alternative.

Management of nuisance pests does not require such "heavy-handed" tactics. These pests, such as aphids on Norway maple, do not threaten the trees but only inconvenience homeowners. With the decreasing popularity of chemical sprays, many communities may find that delegating responsibility for managing these pests to the homeowner is the most desirable option.

Public Nuisances. In order to allow the community to act on a problem, the problem must first be declared a public nuisance. Thus, most ordinances contain a declaration that dead,

defaced, broken, diseased, and dangerous trees are public nuisances. Trees interfering with sidewalks, curbs, streets, and utilities are usually classed as nuisances. Depending on the community's needs, woodpiles on the ground may be considered a public nuisance, because they may harbor mice or other undesirable rodents.

Required Maintenance Provided by City. Some ordinances state that the city shall remove dead trees, hanging limbs, etc. This ploy has been used to guarantee a budget for the urban forestry program, lest the city violate its own ordinance. Be very cautious with this because this clause can greatly extend the city's liability. If the ordinance states that the city shall, for example, remove hazardous trees, the city may be found liable for damages caused by a tree that fails because it did not remove the tree (Borst 1982). Explicitly stating this responsibility should probably be avoided. A better way is to state that the city may remove trees, etc. The city attorney can help you determine if case law in the community warrants use of this clause.

If the ordinance requires homeowners to maintain the trees, the city must enforce it firmly. If it is not enforced, and a tree does fail and cause damage, then the city will probably be liable, unless the homeowner was previously notified to correct the condition. The homeowner would be able to show that he does not possess the expertise to recognize hazardous conditions and that the city which does, did not tell him. Again, the city attorney can provide guidance.

Approved Species. Cultivars. and Varieties. Some communities make the list of approved trees part of the ordinance. While this may be useful, it is better to adopt arboricultural regulations and include the list of approved trees there, or to charge the shade tree commission with developing and maintaining the list. This allows the shade tree commission to change the list as necessary. Often, if the list is incorporated in the ordinance, the ordinance itself must be changed in order to add or delete trees.

The use of a tree list may not be a good idea. The reasons cannot be stated more clearly today than they were by Barker in 1975:

> Selection of trees from such a list often results in the planting of only a few kinds of trees — those that are most readily available at the lowest price. Seldom has such a practice resulted in treelined avenues of appealing beauty. On the other hand, it has often created serious maintenance problems. For this reason, the practice of enabling homeowners to select a tree from a list of official trees has inherent shortcomings.

He proposes as a solution that selection and planting be based upon a tree population density. Based on a current tree inventory, a particular tree could be planted only to a certain population density in the community. In this way, the species composition of the community forest could be regulated. Maximum population density (MPD) is specified for different tree species. None should exceed 5%. (Depending on the tree species that can grow in Interior Western states, you may wish to increase this, but certainly to no more than 10%). Barker categorizes them into Liberal Use (MPD = 5%); Limited Use (MPD = 2%); Candidate Use (MPD= 0.3%); and Deferred Use (MPD adequate for the period).

A sample tree list is provided below. This list could be developed by the city forester in conjunction with the shade tree commission. At one- to five-year intervals, the master tree list should be reviewed and the species moved to different categories where needed. Undesirable trees may be placed upon the deferred tree list so that they cannot be planted until removed from that list. Deferred Use is a more diplomatic means of preventing planting of an undesirable tree species because the term is less likely to offend someone. Tree hardiness, soil tolerance, or overplanting are other reasons for placing a tree on this list.

Partial master list of trees for street use in a sample community:

Liberal use : Population not to exceed 5% of total street trees within city.

Common hackberry	Kentucky coffee tree
Ginkgo	Red oak

Limited use : Population not to exceed 2% of total street trees within city.

Crimean linden	American elm
Littleleaf linden	Green ash

Candidate use : Population not to exceed 0.3% of total street trees within city.

Japanese zelkova	Chinese pistache
Red maple	Chinese elm (*U. parvifolia*)

Deferred use : Population along streets adequate for the next 5-year period.

Norway Maple	Black locust
Boxelder	Cottonwood, all varieties

Replacement Trees. The ordinance may require planting a replacement tree whenever a public tree is removed. It may also set forth guidelines for choosing the species, and some may go as far as to specify the spacing between trees. A payment in lieu may be acceptable, or it may be indicated when a tree is removed and a suitable planting site is not available. The ordinance should specify the fate of any monies collected.

In new developments, some communities require that a tree be planted for every so many feet of street frontage. The city forester may review the site plan prior to issuance of the building permit and indicate a list of acceptable trees. A deposit may be collected when the building permit is issued. If the homeowner or builder has not planted the tree within a certain time, the city will use the money to do so. In this way, a good forest is established with the developing community. In accordance with some plans where uniform street trees are desired, builders may be assessed a fee for tree planting, which will be used by the city to plant the appropriate trees or have them planted.

In some communities, the ordinance designates the minimum spacing between trees and minimum distance from curb and sidewalk, street lights and other utilities. While these restraints may be specified in the ordinance, they are perhaps a matter of policy that could best be stated in the arboricultural regulations to provide more flexibility.

Where natural vegetation exists, some ordinances specify that a certain percentage, say 50%, of the crown cover be retained after development. This initial crown cover can be obtained from aerial photographs. If the proposed development reduces the crown cover below the acceptable level, the ordinance will require that additional trees be planted which will, within some time frame (10 years or at maturity), restore crown cover to acceptable levels. A deposit for tree establishment is often required, and retained by the city until the trees are established, not just planted. A section like this in the ordinance can greatly help developing communities in areas with natural vegetation to retain some of their pre-development character and green space.

Visual Obstruction. This section prohibits any property owner from planting or maintaining vegetation which physically or visually interferes with street traffic. Usually, the height above the street to which vegetation must not interfere is specified, as well as what constitutes a sight obstruction. The responsibility for removing the obstruction may be assigned to the property owner, or the city may be authorized to correct the problem on private property.

This authority may not be necessary, as other ordinances often authorize the city engineer or the streets department to deal with obstructions. The advantage of incorporating such legislation into the ordinance is that all ordinances dealing with trees can be found in one place.

Requirement for Root Barriers. One ordinance (Coeur d' Alene, Idaho) requires that root barriers be installed in the following cases: when curbs, sidewalks or streets are installed less than two feet from an existing tree; during repair of a curb, sidewalk, or street that has been damaged or upheaved by roots of a tree or shrub, when the offending tree is not removed; and when new trees are planted in tree lawns less than two feet wide. The type of barriers, and who is responsible for installation are not specified. This progressive clause may be a useful section to include. The cost of maintaining sidewalks will be decreased. In addition, this reduces liability, which in turn decreases or prevents increases in insurance costs. To provide an idea of the magnitude of the liability problem, Salt Lake City, Utah, paid an average of $3500 for each claim filed by citizens who tripped on sidewalks (Fig 7-1). Small payoffs, yes, but if they are frequent enough, insurance costs will rise, and even of greater concern, citizens will be injured.

Figure 7-1. Trees planted too close to sidewalks—or sidewalks constructed too close to trees—cause premature sidewalk failure which threatens the safety of citizens

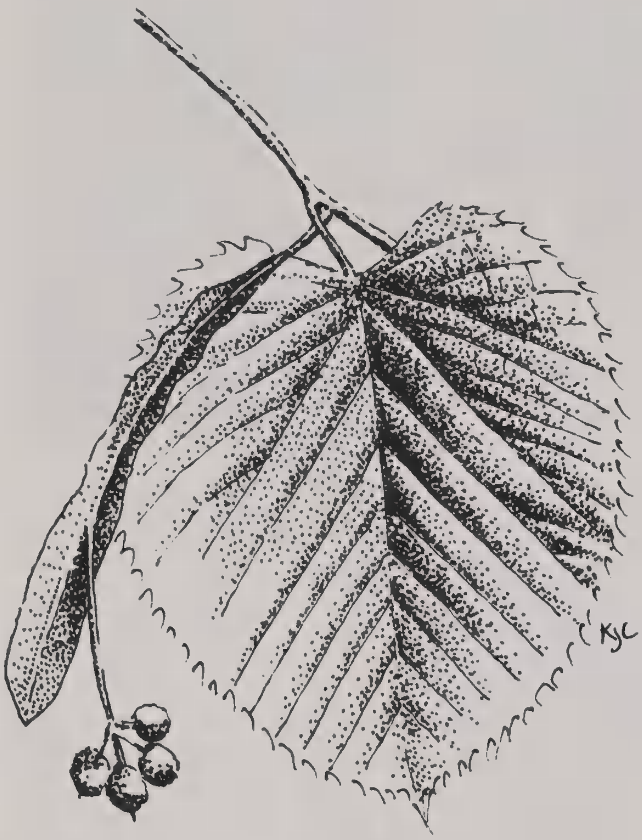
Requirements of Adjacent Property Owners. Many communities require owners of property adjacent to planting strips to water and maintain the strips. Other tree care that may be required by this section could include pruning, removal, planting and pest control.

Requirements of Businesses. If the community perceives a problem with the quality of tree work done by contractors in that community, it may require that any business or individual who contracts to trim, prune, treat or remove trees possess a business license. Such businesses may already fall under the jurisdiction of existing requirements for licenses, but because they are mobile, tree trimmers are more difficult to regulate. Many tree trimming businesses got their start with a pickup truck and a chain saw. This is not necessarily bad, but many of these operators are not trained in proper arboricultural techniques or safety. Requiring them to attend an annual workshop, and/or to be members in the International Society of Arboriculture may cause grumbling among some contractors, but the reputable contractors will appreciate these requirements. Licensing may be an opportunity to require contractors to carry liability insurance. Without such a requirement a sloppy operator may disappear after damaging property, only to surface in another community. A lawsuit may be easily won, but collecting the judgement is often quite difficult. Whether a community requires all contractors to have insurance is a matter of preference, because the reputable contractors already carry insurance, **but all contractors working on city contracts must have liability insurance.** This may be required in the ordinance, or it may be incorporated into the bidding specifications.

Another aspect which might be considered is to require that all contractors' vehicles display the name and address of the firm in legible letters at least three inches high on both sides of the vehicle. This is good advertising for the reputable firms and can help to provide information about those doing questionable work.

Protection of City Trees. This portion of the ordinance prohibits cutting, carving, killing, removing or otherwise damaging any tree on city property without a proper permit if the community issues permits. Posting signs, building tree houses, or engaging in other questionable practices are outlawed. If the city has adopted arboricultural regulations, this section may prohibit work that does not abide by the regulations. Other potential damages which may be prohibited may include fire, allowing harmful gaseous, solid or liquid substances to come in contact with a city tree, and placing or storing on city property stone, brick, sand, concrete or other materials which impede passage of water; air and nutrients to tree roots. Decorative rock gardens or planned landscape materials must be permitted.

Several ordinances explicitly prohibit the practice of topping or dehorning public trees. **All should!** Such a clause may make the strong statement needed to eliminate this practice from many Interior Western communities. Trees damaged by storms or growing under utility wires may be exempted from this clause upon written approval of the city forester. Utilities need to be



educated to the fact that proper tree trimming under lines can greatly reduce the pruning cycle and tree failures. Directional pruning should be done, and in some situations, tree growth regulators can be useful. If they don't know about these techniques, find them articles in the *Journal of Arboriculture*, and/or, invite them to ride with you to the next arborists' workshop in your area.

Protection Near Construction Sites. This section requires that trees on city property near construction sites be protected from stored materials, fill dirt, and vehicles. The ordinance may require that trees be fenced or surrounded by a frame or box. The barrier should be constructed at least 8 feet from the tree, and for larger trees the protective barrier should extend a distance in feet equal to at least 2 times the diameter of the tree measured at 4.5 feet (DBH). Such barriers will minimize impacts of the construction on the tree's root system. Installing utilities below ground by digging trenches is often initially less expensive, but horizontal coring causes less damage to the trees; the combined cost of trenching and subsequent removal of trees killed by the process often exceeds the cost of coring. The ordinance should not designate the type of activity allowed within the protective zone, but should authorize the city forester to use his best judgement in negotiating a workable solution and give him the final authority to enforce that judgement.

Valuation of Trees. This section sets forth the method for determining tree values, and allows the city to collect the assigned tree value from someone who damages the tree. Most often, the International Society of Arboriculture/ Council of Landscape Appraisers system is adopted (Anonymous 1986) If malicious intent can be shown, treble damages may be collected. The ordinance should specify the disposition of any such funds collected.

Appeal of Decisions. The ordinance must provide some method of appealing decisions made by the city forester. An appeal may go to the shade tree commission, to the parks and recreation board, to the mayor, and to the city council, before it ultimately comes before the courts. Regardless of the appeal process, keep in mind that it should proceed as quickly as possible, particularly when a pest problem is involved. Try to streamline the process by making provisions for hearing appeals outside normally scheduled meetings. For instance, if the shade tree commission meets every two months, provide a means to bring the members together, or to inform them of the appeal in writing so the group can act in a more timely manner.

Interference with City Forester. This clause makes it unlawful to hinder, prevent, delay or interfere with the city forester or personnel under his direction while he is executing his duties or enforcing the community tree ordinance. The penalty may be specified here or in its own section. Usually, the penalty is set as a Class C misdemeanor.

Severability. This section specifies that if any section, subsection or any smaller part of the ordinance is found invalid or unconstitutional by any court, that portion of the ordinance shall be deemed a separate, distinct and independent portion of the remainder of the ordinance, and shall not affect the validity of the rest of the ordinance.

What does he plant who plants a tree
He plants, in sap and leaf and wood,
In love of home and loyalty,
And far-cast thought of civic good
His blessing on the neighborhood.

--Charles Lathrop Pack

Liability and Litigation

Insurance costs are increasing rapidly for many communities. Anything that reduces potential liability can slow this increase. This section provides a starting place to understand the

potential liability a community faces. Read the references and other information to learn how the courts are ruling about liability and trees. The references provided can serve as a starting point for entry into the literature. These and other articles can be used to call attention to the potential liabilities facing the community. Work with the city attorney to determine the likelihood of the community's having to deal with these issues. In some communities, litigation is not a serious threat; in others, it can be the catalyst that provides the funding for the community forestry program. The city attorney can assess the legal climate. If he sees a major potential for litigation, he may become a strong proponent of the forestry program.

Defending Against Negligence

By ordinance, many communities assume responsibility to take care of trees and limit unauthorized work by others. Thus the community assumes an exclusive duty to maintain street trees in a safe condition. The greatest threat to the community forestry program is the potential to be considered negligent in caring for trees. Negligence is defined as "a failure to exercise that degree of care which an ordinary prudent person would exercise under the same or similar circumstances" (Barrows 1988a). This term refers to practices that do not meet the standards established by law for the protection of others from reasonable risk of harm.

As an example of negligence, Porter (1981) cites a case in which one stem of a multi-stemmed tree fell on and killed a motorist. The city was considered negligent because the tree grew over the streets. The city had an ordinance allowing it to trespass on private property to inspect trees and to require the owner to remedy the situation, or correct it for him and charge the cost to the property taxes. The city appealed, arguing that the city had no program of inspecting trees, and therefore did not know about the trees. The court ruled in favor of the plaintiff, arguing that the city streets were patrolled by police, who were to see that the streets were safe. Although the police were not tree experts, they were able to see the tree growing over the street and should have notified the parks department head and an assistant, who were considered to have reasonable knowledge of trees.

In order to be considered negligent, it must be demonstrated that:

— there was a duty of care.

— a duty or obligation, recognized by law, requiring the person to conform to a certain standard of conduct, for the protection of others against unreasonable risks.

— there was a failure on the person's part to conform to the standard required.

— there must be a reasonably close causal connection between the conduct and the resulting injury.

— there must be actual loss or damage resulting to the interests of another.

The defenses against negligence, according to DiSanto (1982) are to show (l) that there was no duty of care owed; (2) that there was contributory negligence; (3) that the injured assumed the risk, or (4) that reasonable care was undertaken. The damages claimed may also be challenged by attempting to show that damages were not sustained or that the claimant failed to take steps to reduce or mitigate the damage.

Perhaps the best defense is that of providing reasonable care; this means having a professional, effective tree care program in the community. **The minimum standard of tree care for any community is an annual survey to detect hazardous trees or conditions, a plan to deal with these recognized hazards, and the completion of this work.** Keep complete, written records of the inspection, and especially of the nature of the hazard posed by each tree. If possible, prioritize the hazards in terms of urgency or probability of failure. A rating system such as that used by Bramble (1987) would be very useful in documenting tree condition. Develop a written plan to eliminate these hazardous conditions. The high priority hazards may be corrected first, or the work may proceed first in areas with the most serious hazards. In either case, set priorities, and follow them. Make sure that all hazards are corrected. Keep written records of completion dates. With this type of hazard tree program, you will be able to show that you were working to correct all the known hazards, eliminating the most serious first, or protecting the greatest number of people. This is what a reasonable person would do. If a tree considered to be less hazardous fails you can show that you were working on even more dangerous conditions, and will have a better chance of convincing the court that the failure of the tree was an act of God, over which you have no control.

Establishing an Incident Procedure

The previous discussion concerns the programmatic answer to prevention of tree failures. Even with the best program, trees will fail and damage property. The actions taken immediately after the incident can greatly impact the ultimate resolution of the litigation (DiSanto 1982). In examining the potential for an incident leading to litigation, consider the seriousness of the injury.

Fatalities and serious injuries, especially to children are almost certain to result in a lawsuit (DiSanto 1982). Extensive property damage and emotional issues such as herbicide use can also stimulate legal proceedings. A determination must be made very soon after the incident. Essential evidence is often available at the scene for only a short time after the incident. Once such evidence is lost, it cannot be replaced, and its loss may seriously hamper your case. Every community should have a policy and procedure for investigating incidents, both those that affect the public and those that involve community employees. Tree care is one of the most dangerous professions. Felix (1988) discusses some of the incidents that have happened to tree workers. Although many communities' policies deal effectively with incidents involving employees, few deal with contractors, and many are unclear when dealing with injury to the public or to private property. These policies must also address such issues as claims resulting from pesticide drift.

All communities should prepare written "incident" procedures and distribute them to all employees. DiSanto (1982) suggests many excellent ideas to incorporate into the procedures, including:

A comprehensive, chronological summary of all transactions and events leading up to the claim.

Sketches of the incident scene with details and measured distances.

Photographs of the scene, labeled with date, location from which taken, and photographer's name.

Statements from witnesses, signed if possible, including name, address, occupation and age of witness.

Copies of police and ambulance reports.

A list of all physical evidence, name of item, date of incident, how it relates to incident, and where it is stored.

Copies of all documents pertaining to the incident or claim, eg. memoranda, purchase orders, contracts, policies, and notes.

Clippings of newspaper articles.

Using this list as a starting place, work with the city attorney to develop a procedure that will work in your community. In addition to ensuring that all pertinent evidence is preserved, these procedures should explain how to handle the findings. Because of the rules of discovery, take care to avoid creating information that can fall into the hands of the opposition. These findings can be protected by two options: attorney-client privilege, and the work-product privilege. Should there be an incident, notify the community's attorney as soon as possible. Let the attorney supervise the investigation. Do not make any statements to the press. Oral statements made to third persons should be made by the attorney handling the case. Should you need to prepare for a court appearance, consider the suggestions in Appler (1986).

Promoting Professionalism

As part of the community's long term risk management policy, consider training for professionals (Evans 1981). The term "professionals" used here refers to all community employees. If they are not professional, why do they work for the community? Hire consultants and provide for other on the job training. Promote membership in professional societies such as the International Society of Arboriculture and the National Arborists Association. Encourage employees to enroll in correspondence and continuing education courses and give them time off work to attend class. Such activities enhance their professional abilities and make the employees more credible in court. They also increase worker pride and make workers more loyal to the community.

Every community with employees who work in trees must have written safety standards, and must use and enforce them every day. Standards should be patterned after the American National Standards Z-133 *Safety Requirements for Tree Pruning, Trimming, Repair, or Removal* published by the American National Standards Institute Inc. 1430 Broadway, New York, NY, 10018. This means that the community must provide the proper safety equipment for the work to be done. If adequate equipment is not available, do not assign the task to a city crew: hire a contractor.

Know the resource that you are attempting to manage. A tree inventory is essential. With information from the inventory, set priorities, then maintain the trees in a safe condition. A community must have enough tree workers or sufficient contract services to maintain trees on a frequent schedule. Respond promptly to citizen reports. Evaluate each reported condition, and take action. A community which does not maintain its trees will eventually have to deal with a tree failure which injures someone or damages valuable property. That community will be found negligent, and its insurance company will pay the claim. The community will face increased insurance premiums and will be subject to the ill will of its citizens.

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Ordinances from the following communities were examined in developing this chapter:

Sample ordinance, Illinois. (M. Reichenbach, 5/86)
Salt Lake City, UT
Ogden, UT (proposed)
Logan, UT
Murray, UT
Inver Grove Heights, MN
Falcon Heights, MN
Winnipeg, Manitoba, Canada
Cloquet, MN
Allentown, PA 6 April 1977
Cincinatti, OH (proposed? 1985)
Coeur d'Alene, ID 2 January 1985
Fort Collins, CO
Bicknell, UT

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VIII. PROJECT SITE EVALUATIONS

Visual and Spatial Factors
- Secondary Tree Characteristics

Physical and Biological Factors
- Soil Evaluation
- Air Quality Evaluation
- Local Climatic Evaluation
- Microclimatic Evaluation
- Lighting Evaluation
- Planting Site Constraints

Functional Evaluations
- Local Climate and Microclimatic Control Needs
- Screening Needs
- Noise Control Needs
- Traffic Control Needs
- Erosion Control Needs
- Wildlife Habitat Needs
- Air Quality Improvement Needs
- Planting and Maintenance

VIII. PROJECT SITE EVALUATIONS

PROJECT SITE EVALUATIONS

After a community has developed a Community Forest Plan and developed priorities for removal and maintenance, priorities for future projects including new planting should be established. As monies become available, projects can be tackled one by one. The following section describes a process for deriving workable design solutions at the project site scale. It provides a framework for decision making that virtually eliminates the likelihood of making major mistakes selecting and arranging trees in the community. To avoid costly mistakes due to poor plant arrangement and selection, the following evaluations should be conducted for the project site prior to project design and/or plant selection:

1. **Visual and spatial factors.** The personality of every site is determined by the landscape elements of the site and by the character of the adjacent landscape. The selection of appropriate tree species and their locations can enhance the personality of the site (Figure 8-1).

2. **Physical and biological factors.** To select plants that are ecologically adapted to a site, it is necessary to determine what on-site conditions may limit plant growth.

3. **Functional factors.** As noted in the section on the benefits of the community forest, plants can function effectively in many ways. To utilize plants in a functional manner, it is necessary first to identify what types of functional problems and opportunities exist on the site.

The intent of these evaluations is to identify all the factors which bear upon plant selection and location. On-site investigation will be required. The best way to record the findings of the evaluations is to note them directly on the base map of the project site. The scale of the base map should not be larger than 1" = 20'. If the site is not large, information recorded in the evaluations referred to above can be noted on a single map. If the site encompasses several large blocks the results of each evaluation should be recorded on a separate base map. The maps can be taped together to form a composite, if desired. Examples of recording techniques are included in this section.

Much of the information in this and the following sections will be somewhat technical. If further assistance is needed, contact the state urban forestry coordinator, extension forester, horticulturist, urban forestry consultant, or a local expert. Appendix A lists sources of technical assistance.

Figure 8-1. I'll relax in this Shady, Pleasant Place

Visual and Spatial Factors

After walking or driving through a community, one soon becomes aware that different sections of town have individual personalities. Some derive their personalities from their ethnic origin; others from architectural, historical or geographic features. Any factor or combination of factors can give a neighborhood or an entire community a personality.

Visible personality factors are the most important at a project site scale. Once identified, they can be reinforced through planting design and plant choices. The visible factors which contribute to site personality include:

1. Architecture: style, building materials, scale, proportion, detailing and age.

2. Walks and roads: width, paving materials and pattern.

3. Street furnishings: light standards, signs, fire plugs, phone booths, benches, trash receptacles, etc.

4. Adjacent landscape character: topography, existing vegetation, wildlife, and water.

5. Special features: statuary, fountains, monuments, etc.

When conducting a project site evaluation, describe the major visible factors contributing to the site's personality. This may be done by written description, sketches, photographs or a combination of these techniques. When recorded, this information will be a useful reference for later discussion about tree characteristics appropriate for the site.

How can planting trees reinforce project site personality? Trees have forms, colors, textures, and "character." These elements can be utilized to complement their surroundings. For example, trees with a round form, yellow fall color and fine texture would complement the nicely detailed buff brick buildings typical of many older commercial districts. Trees with these characteristics would highlight the positive qualities of the adjacent buildings. The 16th Street Mall in Denver, Colorado, is a good example of tree selection and composition which heightened the sophisticated qualities of adjacent architecture and retail activity. A word of caution, however, is in order: It is very tempting to plant each project site in a unique way. Succumbing to this temptation will jeopardize the unity of the Forest Plan. Unity is a primary goal of the Plan. The most important thing to remember is to adhere to decisions made in the Forest Plan Map concerning planting composition and tree size. There is ample flexibility within the guidelines of the Forest Plan Map to use secondary tree characteristics to express project site personality.

Secondary Tree Characteristics

Secondary plant characteristics include form, color and texture. Although they are visually less significant than tree size, keep the following recommendations in mind:

Form or the mature shape and growth pattern of trees should be considered in several ways:

1. The choices of plant form and massing should reflect the planting pattern and tree size guidelines established in the Forest Plan.

2. The use of tree clumps or tracery is most applicable for informal planting schemes. Canopy and fenestration planting patterns are best used in formal geometric plantings. Figure 8-2 shows examples of these patterns.

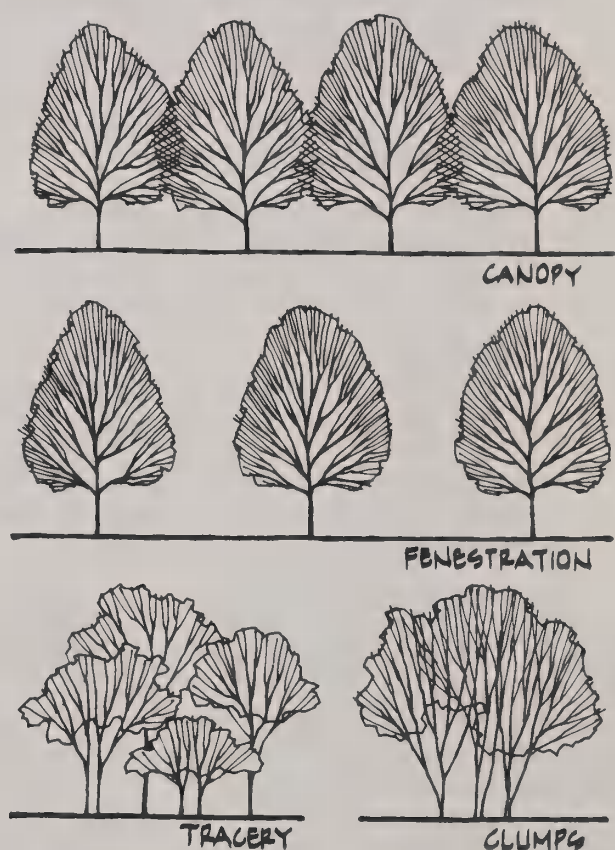

Figure 8-2. Examples of Planting Schemes

3. Select plant forms that harmonize with the adjacent architecture and landforms. Round, oval, columnar, or broad base pyramidal tree forms are most compatible with the architecture typical of communities. Pyramidal or weeping forms are best utilized for special effects. For examples of plant forms see Figure 8-3.

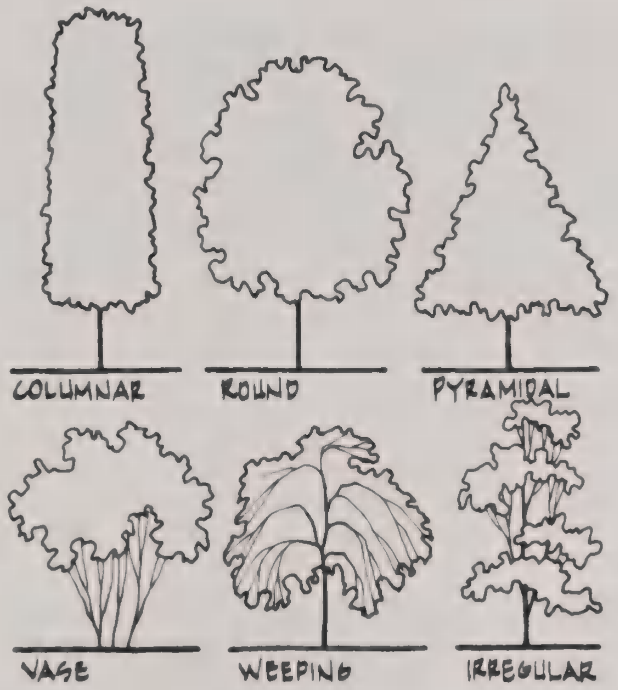

Figure 8-3. Examples of Plant Forms

4. Select plant forms that will survive in the space available for planting, not only when first planted, but as mature trees.

5. Sometimes a striking specimen plant will accent a setting and create interest. However, extreme contrast in plant form within the same planting project site should be avoided. Such contrasts will detract from the overall unity of the project.

Color. Over the years, several generally recognized color schemes have evolved in various fields of art and design. These color schemes are not cookbook recipes for success but rather guides for color choices. They include the following:

1. Monochromatic: The use of shades and brightness of the same color. Monochromatic schemes are subtle with a strong sense of unity. Subtle changes are obtained by varying the value and intensity of the theme color. Selecting several species of trees with dark green foliage for a project planting site would result in a monochromatic scheme.

2. Analogous: The use of related adjacent colors – red, red orange, orange and yellow, for example. Analogous color schemes retain many of the subtle qualities of a monochromatic scheme but with more variety. Interesting visual rhythms and subtle accents can be achieved through the use of analogous colors. A park planting of oaks, maples and aspen would produce colors of yellow, red and yellow orange — an example of an analogous fall color scheme.

3. Complementary: The use of colors opposite each other on the color wheel. Complementary colors produce the maximum visual impact. Consequently, complementary schemes are used where strong accents are desired. A common example is to place sugar maples which turn bright red in the fall among evergreen trees. The evergreen background accentuates the red fall color of the maples.

Less common color schemes include split complementary and triad. Figure 8-4 below offers an example of color scheme possibilities.

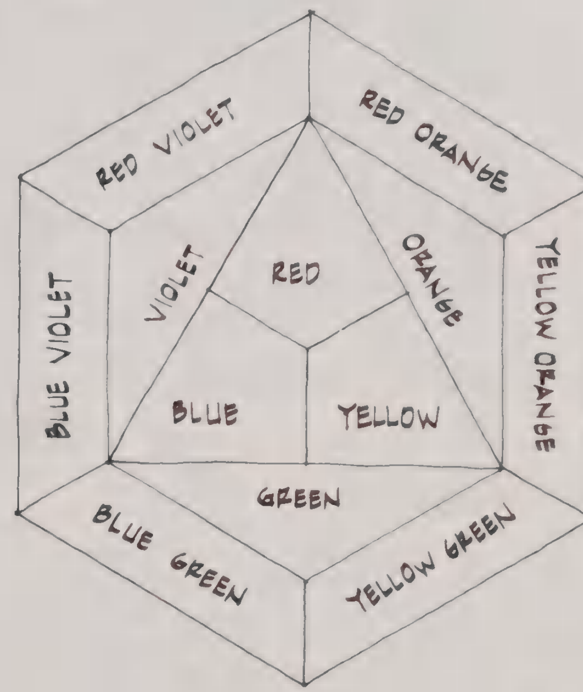

Figure 8-4. The Color Wheel

Below are some general guidelines for the use of tree color on a project site:

1. Establish seasonal color schemes as a guide to color choice for the project site.

2. Select seasonal tree colors that relate by complement or contrast to the surrounding architecture and landscape.

3. Use a mass of the same color. At the scale of a project site, color effects are best achieved by the use of a mass of the same seasonal colors. Single specimen trees are usually ineffective; they become lost in the visual complexity that surrounds them unless they are in highly visible locations.

4. Random or excessive use of color can produce undesirable effects.

Texture. Also important is the texture of the plant when it is viewed at a distance and related to background architecture or landscape. Trees with fine textures may allow some visual penetration through the canopy. This characteristic may be important where visual penetration is desirable, in a business district for example. Fine-textured plants are also compatible with finely-detailed architecture — the two complement each other. Coarse-textured dense plants are useful for screening and complement coarse-textured buildings and landscapes. Coarse-textured plants are also useful when used in mass in parks and other large open spaces.

Contrasting textures can be useful in creating subtle accents. Some guidelines for textural choices at a project site scale include:

1. Establish a texture theme for the project site that reflects the plant characteristics guidelines established in the forest plan.
2. Relate the textural choices to those of surrounding architecture and landscape.
3. Beware of random mixing of textures.
4. Use fine-textured trees that do not have a dense canopy on sites where dappled sunlight is essential.

The basic objective of a visual and spatial inventory and analysis of the project site is to produce criteria for the selection of appropriate trees. The most appropriate trees for the project site will be those which meet not only the visual criteria but also the physical, biological, and functional criteria to be discussed in the following sections.

Physical and Biological Factors

The tolerance of plants to conditions of the site environment varies with species. Optimal plant growth and development, is achieved by either (1) supplying (2) or where possible, matching a plant's unique temperature, soil, water, light, and nutrient requirements. The latter costs less initially and in long-term maintenance costs.

New transplants are less tolerant of improper growth conditions because they have far fewer feeder roots and stored carbohydrates (food) than established plants. "Transplant shock" due to poor selection and improper planting technique makes the tree vulnerable to pest damage or death caused by environmental stresses. Therefore, selecting a plant that will thrive requires an understanding of the physical and biological characteristics of the site in which the plant will be located and its ability to grow and develop given those parameters. This section describes environmental conditions that will often limit plant establishment and growth in the community setting. These conditions should be evaluated at the site and recorded on the Project Site Evaluation base map. In some cases a more sophisticated technical analysis of a factor may be needed. Sources of assistance are noted in the text and Appendix A.

Soil Evaluation

Soil is the medium which provides plants with support, moisture, oxygen and nutrients as well as a means of interacting with other organisms. A healthy root system is essential to the growth of a vigorous plant; therefore, a plant must be in a soil environment that is conducive to healthy root growth to grow successfully. Unfortunately most urban soils are not ideal. Unlike undisturbed, natural soils, urban soils have been drastically impacted, changing their ability to effectively support plant growth. Craul (1988) has discussed important soil characteristics that change with urbanization:

1. Great vertical and horizontal variability.
2. A modified structure tending toward compaction.
3. Altered plant-soil-water relations,—infiltration, percolation, water holding capacity, water logging, drought.
4. Water-repellent, surface crusting of bare soil.
5. A modified soil pH, usually becoming more alkaline.
6. Restricted aeration and drainage.
7. Interrupted nutrient cycling.
8. Modified organism activity.
9. The presence of man-made materials and contaminants.
10. Modified soil temperatures.

These, along with other soil characteristics affect root development and plant growth. The challenge is to assess urban soils accordingly, select adapted plants or modify unacceptable conditions. For a more complete understanding of urban soils and their unique characteristics read Chapter XI.

Soil Morphology. Urban soils are disturbed soils. They have been mixed vertically and horizontally during construction (Kays, 1982). Trenching, scraping, digging, cutting, filling, all contribute to the variability. Infertile, inorganic, poorly drained, heavy subsoils are often brought to the surface, spread out over the top soil, compacted to meet construction codes and then planted. These activities create abrupt changes and areas of great diversity in chemical and physical soil properties throughout the soil profile and over the landscape. Texture, structure, organic matter content, bulk density, nutrient content, pH, and salinity levels, are all affected and in turn, influence drainage, water-holding capacity, infiltration, aeration, and fertility, — ultimately increasing the potential for plant stress.

Moderate to severe problems also occur when cuts place parent materials, bedrock or seasonal water tables within less than four to six feet of the soil surface. Or if impermeable layers are naturally present or are created by thoughtlessly replacing stockpiled topsoil on top of subsoils without creating a transition zone by roto-tilling some of the topsoil into the subsoil, then roots will be water-logged by a perched water table and die. Massive or platy profiles also produce perched water tables.

Make a viewing trench or take core samples in order to visually assess these and other morphological characteristics. Fill planting holes with water and observe how quickly water will drain away. If problems exist, deep tillage, 36" to 60" deep, or installing drains may make the site plantable. In any case, **do not** plant trees in areas with impermeable layers, shallow water tables or poor drainage — they will **die!**

Cuts and fills during landscape construction may expose or cover roots. Exposed roots dry out and die back. The loss of roots restricts water and nutrient absorption by the tree. Transpirational demand for water will not be met and limbs will die back. As well, open wounds and stubs are entry sites for disease organisms which will further cause the tree to deteriorate over time. Putting several inches to several feet of fill over an existing root system restricts air movement within the root zone. Without oxygen, roots and micro-organisms will begin to respire anaerobically producing heat and toxic chemicals. Within a short time the roots will be invaded by secondary, root-rot causing pathogens. If grade changes are made around existing trees, provisions must be made to reduce root damage from exposure and suffocation.

Soil Compaction. Flooding, trenching, excavating, cutting, stockpiling soil or construction materials, any heavy equipment activity and even frequent light vehicle and foot traffic destroys soil aggregation, compacting the soil. Silts, clays and loams containing both silt and clay, readily compact. Air and water movement into and through compacted soils is greatly restricted. Without either, roots cannot grow; in fact, they die when water or air is limiting. Compacted soils become water-logged, deficient in oxygen, saturated with toxic levels of carbon dioxide and/or often contain soil pollutants.

Compaction increases soil density. Roots can not penetrate soils with a bulk density greater than 1.70 megagrams/cubic meter (Mg/m^3). Many urban soils may exceed this value. Bulk densities for clays and silts should be less than 1.4 Mg/m^3 and loams less than 1.6 Mg/m^3 to allow tree roots to penetrate and grow.

Vegetation does not grow in compacted soils. Soil treatments which significantly aerate soils reduce soil compaction. Deep, two to four foot, tillage is most effective in reducing compaction.

Crusting. Crusting occurs when traffic and beating raindrops fill the soil pores with fine particles. Crusts become hydrophobic and impermeable to water. Soils beneath crusts are

powder dry even after rain or irrigation. Rotary-tilling lightweight aggregates (such as expanded slate and industrial fly ash) into soils reduces surface compaction to the depth of the tilling. Compost of leaves, wood chips, sewage sludge and other organics incorporated into soils as deeply as possible not only reduces soil compaction but increases soil fertility and organic content. Gypsum, worked into sodic soils improves flocculation, porosity and drainage as it alleviates crusting.

Because poor porosity restricts infiltration and drainage, crusted soils experience greater runoff, surface erosion, puddling and are often bone dry beneath the crust.

Soil pH. pH is the measure of soil acidity or alkalinity. Soils of the Interior West are slightly alkaline with a pH range of 7 to 8 or higher. When the pH is either excessively low or high, elements essential for plant growth and development become unavailable or available in excess and create nutrient deficiency or toxicity in the plant. For example, as soil alkalinity increases, the roots can not absorb iron, manganese, zinc, copper or boron because these elements remain attached to the soil particles. The insolubility of iron above pH 6.7 causes iron chlorosis or interveinal leaf yellowing in many trees. Chronically susceptible species should not be planted in alkaline soils.

Urban soils tend to have an elevated pH compared to surrounding soils (Craul, 1988). Apparently, weathering of mortar, concrete and other lime or calcium rich building materials contributes to the rise. Selection of adapted trees and appropriate maintenance practices can minimize the problem.

Saline and Sodic Soils. Salty or saline soils are common to arid regions of the world and are found throughout the Interior West, especially were evaporation exceeds precipitation. Soluble salts washed from mountains and hills accumulate in valley soils as evaporation removes the water and leaves the salts behind. Few plants tolerate even moderately saline soils. Salty soils inhibit seed germination, stunt root and shoot growth, and cause leaves to scorch or exhibit drying at the margins, turn yellow and wither. If sodium salts are present, soils become sodic and do not support plant life. Periodic, thorough leaching with salt free water will reduce or remove salts from the soil, provided drainage is good. Selection of salt-tolerant plants is essential for planting in these settings.

Sodic soils must be treated with gypsum and then leached with good quality water. Reclaiming sodic soils takes many years.

Refer to Appendix C and the Tree Section Matrix in Chapter IX to select tress adapted or tolerant to iron chlorosis, alkaline, sodic and/or saline soils.

Soil Fertility. In undisturbed, natural forests, litter from closely spaced trees accumulates, is decomposed by beneficial organisms and eventually the elements left behind are absorbed by the trees. Practically no nutrient recycling occurs in urban landscapes. Trees are spaced too far apart to accumulate much tree litter and winds or maintenance personnel carry most of it away. Urban soils of the Interior West also contain little organic matter because low precipitation rates and alkaline soils do not support soil-borne organisms well. Consequently, the population of beneficial organisms that recycle nutrients is relative low. Likewise, the nutrient- and micro-organism-rich A horizon is often removed during construction and replaced with a few inches of "top" soil. Thus, infertile urban soils do not furnish trees with the minerals they need to grow, nor do they provide a good habitat for soil micro-organisms.

Happily, infertile soils can be treated more easily and economically than compacted and disturbed soils. Roto-tilling organic matter into the topsoil restores some micro-organisms and applying commercial fertilizers compensates for the low fertility. At the University of Nebraska, Lincoln campus, organic mulches, such as wood chips, are supplemented with nitrogen to effectively and economically improve campus soils. For more information on fertilizers, see Chapter XII.

Organic Matter. Soils in the Interior West contain little organic matter compared to other regions of the United States. Living microflora and dead organics make up the organic content of the soil and provide numerous benefits. Dead organic matter is broken down by soil flora and fauna, releasing nutrients into the soil solution in a useable form for plants. Many soil organisms mineralize insoluble forms of nutrients and minerals, making them readily available to plants. As well, organic acids from wastes and decay of microflora lower the pH of an alkaline soil which makes more elements available. Soil organisms also "fix" nitrogen which transforms atmospheric nitrogen that cannot be taken up by plants in the gaseous form into chemical compounds that can

be utilized by plants. Soil mycorrhizae are important in nitrogen, phosphorus, and sulfur cycling. They also help roots absorb water and nutrients more efficiently. Micro-organisms oxidize toxic wastes and prevent some elements like iron and manganese from becoming toxic. The mucilages and gums of microflora aggregate soil particles and improve soil structure which increases aeration, percolation and drainage. And where there is a normal balance of micro-organisms in the soil, the competition between them for resources prevents the proliferation of soil-born disease organisms detrimental to trees.

Soil Contamination and Pollution. Unfortunately most urban soils are contaminated with construction debris and litter. Soils and groundwaters are also becoming increasingly polluted with petroleum products, pesticides, heavy metals, radioactive materials, exotic gasses and salts. In the past, de-icing salts, herbicides and animal excreta were the major pollutants, but today more exotic contaminants abound.

Knowing the history of a planting site is all-important. Waste areas, landfills and razed industrial sites may be the source of numerous pollutants as well as debris that could interfere with plant growth. The debris may be physically removed, but to eliminate the pollutants may require excavation and replacement of contaminated soils with clean soil. The isolation, neutralization or inactivation of some pollutants may be possible, but costly. It is best to avoid polluted sites with their costly clean-up and disposal headaches in the first place.

De-icing salts ($NaCl$ and $CaCl_2$) are frequently used on city streets and sidewalks to remove ice and snow. It is estimated that 7000 trees, mostly conifers, along streets and arterials in the Tahoe Basin were damaged by de-icing salts applied during the winters of 1987-88 and 1988-89.

Salty spray drift on dormant stems and buds of deciduous trees and stems, buds, and leaves of evergreens, as well as excess amounts of salts leached into the root zones adjacent to walks and roads injures and, if prolonged, kills plants. Plants resistant to soil salts and those resistant to salt spray are not necessarily the same species.

Dirr (1976) found that plants injured by absorbing salts are often stunted and may exhibit yellowing or dropping of the lower leaves. Some plants show no significant leaf discoloration but will have growth differences. Symptoms of aerial salt injury to plants include needle browning and twig dieback on the sides of evergreens facing the road. The leaf buds of deciduous trees will be slow to open, and new growth may have a tufted or witches-broom appearance.

High concentrations of salts in the root zone are more damaging to plants than is salt spray. Unhealthy concentrations often result from plowing snow onto plantings and as the snow melts, the salts are leached into the root zone. High concentrations of salts about the roots cause the plant to desiccate. Selected salt-tolerant plants are listed in Appendix C. It should be noted that these plants cannot be recommended unequivocally because substantiating research is not complete and growing conditions of the planting may affect the plant response to higher than normal salt levels.

Minimize or eliminate salt damage to woody plants by employing one or more of the following management techniques:

1. Avoid de-icing salts completely or reduce the quantities applied.

2. Leach salt-affected soils and wash plant parts exposed to aerial salt drift with clean (salt-free) water as soon as circumstances permit.

3. Place barriers such as canvas covered fences, snow fencing, tall berms, or salt-tolerant plants to protect shoots of sensitive species and use swales, gutters, low berms or concrete lips to channel salty water away from plant roots.

4. Remove roadside snowbanks before they melt and do not pile salt-contaminated snow around the trunks of trees near entrances, in parking lots or beside driveways.

5. Prune injured shoots and water trees well with good quality water to leach salts away. Do not apply fertilizers until excess soil salts are removed.

6. Initiate a pest management program. Weakened, salt-stressed plants are attacked by insects and diseases to which healthy plants are resistant.

7. Use plants tolerant to expected amounts and types of salt, soil or aerial spray, in the plantings.

8. Treat plants exposed to salt spray with a clean water drenching if the spray has been light.

9. Add an adjustable skirt to spreaders to control the spray pattern. Avoid applying salt to plantings with equipment.

Inappropriate herbicide use or application severely damages or kills trees. Commonly a mistake in application rate is made or an herbicide to which some trees are susceptible is applied. Many lawn weed and feed products are available and if improperly used will kill trees. However, on occasions nonselective herbicides used to destroy vegetation and keep seeds from sprouting along highways, walks, fences, and under pavement is inadvertently transported by surface or underground water into ornamental plantings. Injury and stress may not appear until several years after application, but on occasion has been acute and readily apparent.

In February 1986, a freak rainstorm dropped several inches of water on Reno, Nevada, over a two-day period. Unfortunately, the city maintenance crew had applied a soil sterilant to several miles of roadside the week before and the excessive rains eroded the top layer of bare soil and washed it into several adjacent back yards. Trees, shrubs and turf were damaged or killed and had to be replaced at the city's expense.

The most common symptom of herbicide injury is distorted leaves and twigs. Leaves are typically curled or twisted and leaf stems often curl downward, forming a loop with the leaf. Conifers display brown needle tips if soil applied herbicides are present.

Avoid herbicide damage by applying herbicides sparingly and only when needed. Follow the label instructions exactly **with one exception.** Many weed and feed products instruct applicators to apply the product up to, but outside the drip line of a tree's canopy. This is a mistake. Absorbing roots of trees are found in the top two to three feet of soil and extend away from the trunk a distance equal to two or more canopy diameters. No one told the roots to only grow under the tree's canopy, **so they don't!** Do not apply herbicides within this extended area — within two diameters of the tree's canopy diameter to the trunk. Young trees are particularly susceptible to herbicide damage and should not have herbicides spread about their base, especially multiple applications in the same season. If herbicide injury symptoms are apparent, do not repeat applications. Select less volatile and toxic chemicals for use near trees.

Apply herbicides on windless days, early in the morning and use a coarse spray to minimize aerial drift. Eliminate stress in trees that exhibit herbicide injury symptoms to lessen the effect of the herbicide on the trees.

Never allow landscape fill suspected of being contaminated with herbicide to be used around or in planting sites. And always specify that top soil or fill dirt be tested and certified free of pesticides, especially herbicide residues.

The chemical concentration and quantity of animal excreta along city streets can severely damage and sometimes kill trees, especially young or stressed trees. There is a mistaken notion that because barnyard manure is used for fertilizer, all animal excreta is beneficial to plants. There are a number of technical reasons why this is not true.

Animal urine in high concentration is toxic to plants. Manures must be well-leached before they are used as fertilizer, otherwise their chemical salt concentration damages plants (Arnold, 1980, p. 131).

Animal excreta causes a gradual decline in vigor and is difficult to deal with since it has little immediate effect on the appearance or apparent health of nearby trees. Most people are not aware that fresh animal wastes slowly kill trees and every effort should be made to make the public aware of the problem. Likewise, regulations in parks and public places must require animals be leashed and feces removed by the animal's master. Animal control must also remove homeless animals from the streets to reduce damage.

Increased Temperatures. Urban environments are warmer than surrounding natural areas. Exposure to greater solar radiation along with the accumulation and storage of heat by buildings, walks, roads — all manner of concrete, asphalt and metal structures, increases both atmospheric and soil temperatures. High light and elevated temperatures increases plant stress, especially transpirational stress. Coupled with limited soil volume, crusting, compacted soils with poor aeration and drainage, polluted conditions and little available moisture, trees become severely stressed and growth is negligible.

Soil Moisture. Tree growth and tree health are greatly affected by the consistent availability of soil moisture. Water is a principle growth regulator necessary for vigorous plant growth. The above mentioned soil characteristics greatly influence how much and how often water will be available. Each must be considered with regard to its effect on soil moisture and modified to improve plant-soil-water relations whenever possible. Too little, too much and inconsistent levels of water, particularly acute changes in available soil moisture creates tree stress that often leads to tree decline and death. Many newly planted trees fail for lack of water or because crowns are too wet. In the Interior West, care must be given to avoid drought stress in trees by supplying supplemental water, reducing competition from weeds (turf is the major water competitor for newly planted trees) and selecting drought tolerant species and cultivars.

Note on the base map of the project site areas where heavy equipment will not be allowed, contouring and root protection is necessary, soils are compacted, polluted, infertile, salty or pH levels are undesirably high or low. Then plan and implement appropriate actions to correct unfavorable site conditions and install adapted trees. Special considerations in plant selection and soil preparation prior to planting will do much to reduce costs and insure a successful, vigorous planting.

Air Quality Evaluation

Plants can improve the quality of the urban environment by reducing the quantity of atmospheric pollutants. The degree to which a tree species can do this is dependent upon its tolerance to air pollution. Highly susceptible species will succumb to air pollutants sooner than tolerant species and, therefore, should not be planted in areas with poor air quality during the growing season. An arborist seeking pollution-resistant trees must first acquire a listing of the air pollutants in the area. Although this is very difficult to determine, the arborist can get assistance from the local Extension Service or university, the state public health department, from meteorologists, and from large local industries and utilities which monitor air quality. **Plant damage caused by air pollution is, within this region, concentrated in the major metropolitan areas and not a significant problem in outlying rural communities.** Many good color guides to air pollution injury are available (see references). These can be helpful in diagnosing potential air pollution injury.

Sulfur dioxide. "Sulfur dioxide and ozone are responsible for more air pollution injury than all other air pollutants combined" (Davis and Gerhold,

1976, p. 61). Burning coal accounts for most sulfur dioxide released in the United States. The production, refining, and combustion of natural gas adds approximately 20 percent to total sulfur dioxide emissions. Ore smelting and refining, along with industries that manufacture sulfuric acid and sulfur, account for the remaining sulfur dioxide in the environment.

Plant damage occurs when the gases get into the inner leaf where they destroy leaf tissues. Typical sulfur dioxide injury on broad-leaved trees appears as yellow or tan areas between the leaf veins. Sulfur dioxide injury on conifers appears as a reddish-brown discoloration of the needle tip. Defoliation may occur with time, giving the crown a sparse, tufted appearance.

Ozone. Ozone pollution is primarily a result of hydrocarbons and nitrogen oxides emitted into the atmosphere from vehicle exhaust. Once in the atmosphere, these compounds undergo photochemical reactions in the presence of sunlight to produce ozone and a variety of other compounds, such as nitrogen dioxide and peroxylnitrates (PAN). Ozone formed in this manner may travel long distances and cause plant injury.

High concentrations of ozone affect the normal processes of tree growth. Symptoms of ozone damage to broadleaved trees appear as small flecks or stipples of light-colored or reddish-purple tissue on the upper leaf surface. Ozone injury to conifers appears as a chlorotic mottling of the needle or death of the needle in severe cases. As with most pollutants, ozone may induce premature defoliation of older needles.

Fluorine. Fluorine is about 100 times more poisonous to plants than sulfur dioxide; thus fluorine will cause damage even at very low concentrations. Fluorides may cause extensive damage around large point sources such as smelters, fertilizer plants and industries which produce aluminum, steel, and ceramics. Fluorine damage to plants causes a ship-like turning up of the leaf blade and dried up needle points on conifers.

Bernatzky (1978) writes, concerning air pollution resistance in general, that deciduous trees and shrubs are more resistant than conifers. Young conifers are more resistant than older ones. Broad-leaved evergreens are more resistant than those with narrow leaves. However, resistance is always relative and dependent upon the following:

1. The type of emission (kind of gas), its intensity and the duration of its influence.

2. The plant's phase of development (age, season, health).

3. Growth conditions (soil, climate, nutrition).

4. Location.

These factors should be considered when looking for evidence of air pollutants on urban vegetation. Observations of plant damage due to air pollutants provides valuable information concerning the local presence and concentration of various pollutants. The relative tolerances of selected tree species to air pollutants are listed in Appendix C.

Local Climatic Evaluation

The climate of a city or the locale in which a city lies, such as a valley, plays an important role in the selection and placement of vegetation. **Plants that are adapted to the regional extremes of temperature, precipitation, and wind will have a much higher survival rate than those only marginally adapted to these environmental conditions.** Adapted plants translate into reduced maintenance and replacement costs for the urban forestry program. This section will concern itself with the evaluation of local climatic variables and their impact on plant materials. When analyzing the specific planting site within a community, consider carefully the microclimate (climate of the immediate planting site). A discussion of the microclimate evaluation process is presented later in this chapter.

Temperature. Because temperature affects plant hardiness, the range of a given tree species is limited by latitude and elevation. Beyond these range limits, the species cannot survive the cold weather. Within Interior Western States, there are five climate zones delineated by Arnold Arboretum (Figure 8-5). The primary consideration used in establishing these zones is average annual minimum temperatures. Plants that are hardy in a given climate zone will be able to survive normal minimum winter temperatures. Mature plants tend to be more hardy than young transplants. Trees that have proven to be hardy and adapted to local soils are listed for each climate zone in Appendix C-5. The locations of hardiness zones are shown in Figure 8-5.

Occasionally plants that are normally hardy in a given climate zone will be injured or killed by extremely cold temperatures. For example, in Salt Lake City the average annual minimum temperature is -5°F, but the extreme minimum is -30°F (Hubbard and Richardson, 1979). It is important to consider the temperature extremes that have been recorded in your area.

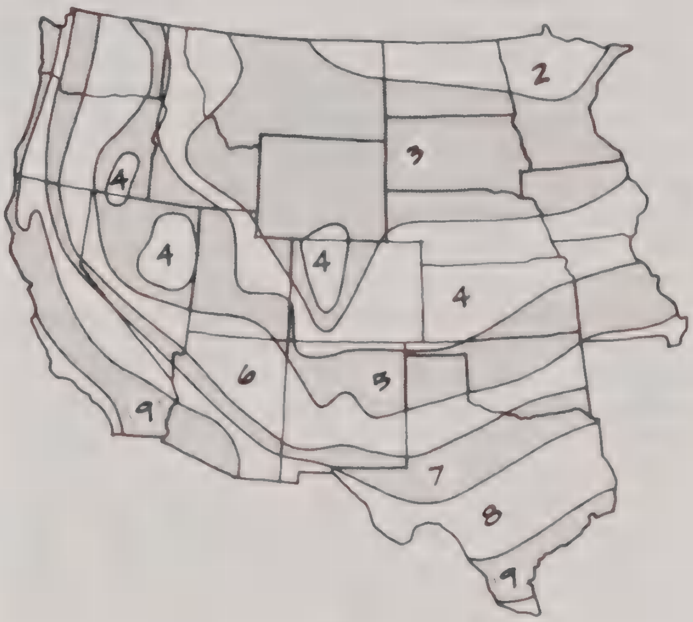

Figure 8-5. Hardiness Zone Map Compiled by Arnold Arboretum

In some areas of the Interior Western region maximum temperatures also limit plant growth. Plants not adapted to large amounts of sunlight, low soil moisture, and high temperatures will not grow normally unless special measures are taken. This is especially true in the desert regions. Although little data is available as to which ornamental species can tolerate high temperatures, it is an important factor to consider when evaluating the project site and selecting tree species. The Western Garden Book does have some information about high temperature tolerance for the western states.

A number of studies have compared rural and urban temperatures. Urban conditions produce summer and winter temperatures consistently higher (by 3.5° to 9°F) than rural areas. This effect, called the "urban heat island," is due to the extensive heat absorbing and radiating surfaces characteristic of the cityscape. In large cities this is a factor to consider when selecting plants. The warmer temperatures and sheltered areas within the city may provide a thermal environment hospitable to plants otherwise unable to survive in that climatic zone.

Precipitation. Much of the Interior West is semi-arid, particularly, the steppe, desert, and prairie lands. The lack of precipitation often limits plant growth and survival unless irrigation is provided. In parts of this region, water is a scarce resource. Some municipalities in California, Colorado, and Arizona have instituted xeriscape ordinances or incentive programs. Xeriscape describes site preparation, plant selection, maintenance, and other techniques for conserving water. Planting drought-tolerant species in low-water landscapes is a major tenant of xeriscaping. Although a scarcity of water available for landscape irrigation is not a severe problem in most of the region, the cost of water is increasing due to a decreasing supply and increasing demand. "Conversion to desert landscapes or native scenes as well as adoption of water-efficient sprinkling methods by an entire neighborhood could drastically reduce average and peak day use. Deferment of system expansion and decreases in operating costs would be tangible if these methods were implemented" (Flack, Weakley, Hill, 1977, p. 115). In the future, mandates favoring the use of less water-demanding species, including turf, will become commonplace.

It is important to evaluate the amount and seasonal availability of natural precipitation in your area. Generally, both drought-tolerant and non-drought-tolerant species require additional water to insure establishment. However, the long term costs of maintaining a drought-tolerant plant will be less than that of the non-drought-tolerant species. Xeriscaping concepts are discussed in detail in Chapter X. A list of selected drought-tolerant tree species is presented in Appendix C.

Wind. Wind affects plant growth and form as well as human comfort. Strong winds combined with high air temperatures dry out insufficiently irrigated plants. Winter winds can also desiccate trees, particularly evergreens.

When evaluating the regional airflow patterns of an area, consider the local topography, wind velocity, prevailing wind direction and the time of the year and day. In mountainous terrain, daily wind patterns are frequently more important than the upper airflows. These diurnal winds flow downvalley during the evening and early morning hours and up the valley during the afternoon. This type of airflow pattern is generally stronger in the summer than in the winter. The upper airflow patterns tend to be more dominant during the cold winter months in mountainous terrain and year round in areas with uniform topography. These wind flow patterns should be identified so that tolerant vegetation can be selected and located to control snow deposition on roads, reduce fuel consumption for space heating, and increase human thermal comfort. A more detailed discussion on the use of wind control plantings is included in the next section.

Microclimatic Evaluation

Microclimate is a product of the interaction of the climatic factors with the physical and biological factors of a site. Whereas the local climatic

patterns may extend for 10's or 100's of acres, a microclimate is generally regarded as the climate of a small area (less than 10 acres). The microclimates of small areas vary considerably in response to such things as the orientation of buildings and streets, the heat absorbing and reflecting properties of construction materials, the amount of vegetation present and the thermal outputs of buildings. The tolerance of trees to microclimatic extremes varies with species. Therefore, it is necessary to evaluate the presence and severity of microclimatic factors at the project site. This includes seasonal changes in the microclimate as they affect plant growth, stress and survivability. Microclimatic conditions commonly found in and around the cities of the Interior Western states will be identified.

Temperature. The identification of hot and cold pockets will help in the eventual selection of tree species. In mountain valleys, frost pockets frequently are found in local depressions, river bottoms and valley bottoms. Dense, cold air settles in these low-lying areas, causing what is known as an inversion. Because temperatures are cooler in these frost pockets, plants of marginal hardiness are susceptible to frost damage, dieback or winter kill.

Thermal belts are warm zones that lie above the inversion layer. In many cases the upper benches along the Wasatch Front in Utah are thermal belts. Temperatures are warmer in the winter and cooler in the summer than in the valley bottoms. Thus, the urban forester has a wider selection of plants to choose from for planting where thermal belts exist.

Hot and cold pockets also exist around buildings. For example, the south sides of structures are generally warmer and have greater diurnal fluctuations than the north sides. The south side receives direct solar radiation most of the day, while the north face is in shade. The south side is also warmed by heat energy radiated from the south wall and paving materials (including decorative gravels) on the ground. The combination of higher temperatures and lower humidity in these hot pockets can increase heat stress on internal plant tissues.

Thermoavoidance is the ability of plants to adjust to or resist injurious external heat loads. The most important thermoavoidance mechanism is transpirational cooling. "Transpirational cooling can lower internal leaf temperatures from 2° to 5°C, or perhaps more, below surface conditions. This decrease may be just enough to reduce temperatures below the lethal range" (Andresen, 1976, p. 71). However, there must be adequate soil moisture for transpirational cooling to occur.

During the winter much of the Interior West experiences extreme, daily temperature fluctuations, often in excess of 40° and 50°F. Likewise, open bright wintery days expose trunk and limb bark of deciduous trees to direct sun which heats the bark to several degrees over ambient temperature. Daily freezing and thawing causes bark to crack, split, dehydrate and over time die, especially on the south and west sides of trunks and limbs. Similarly, the south and west sides of evergreens suffer dehydration and die-back.

Thin barked trees and sensitive evergreens should not be planted where high light and fluctuating daily temperatures limit their growth or survival. Where necessary, paint trunks and limbs with white reflecting latex paint or provide temporary shade during the winter with burlap wraps or simple structures to prevent damage. Young, newly planted deciduous trees are especially susceptible to exposure damage and should be protected until their canopy develops enough to be self shading.

When examining specific planting sites, note the extreme temperatures of surfaces close to the proposed tree. Andresen (1976) reports that on a bright summer day, the temperatures of a west-exposed wall and a parking-lot pavement were over 45°C (113°F), while the surface of a grass lawn was 33°C (91°F), and the air over grass and an enclosed paved courtyard was 31°C (88°F). Infrared radiation reaching trees from adjacent emitters might heat the surfaces, especially of bark, to temperatures similar to the source. If tree tissues are already under moisture stress, such temperatures might have damaging, possibly lethal, effects. Thus, you should note on the Project Site Evaluation base map where hot and cold microclimates exist so that hardy and tolerant species can be selected.

Natural Light. The amount of solar radiation available to trees may vary greatly for trees on opposite sides of the same street. For example the north side of a street running east-west receives far more light than its south side due to shading from structures to the south. In streets running north-south, light and shade values are almost equal if the buildings are of similar dimensions. Buildings vary the distribution of the sun's radiation by their dimensions, orientation, and reflectivity qualities. In large cities air pollution further reduces the amount of sunlight by darkening the environment and depositing particulate matter on leaf surfaces. As the amount of available light declines from the optimum for photosynthesis, branching becomes more sparse and often tree shape is distorted as the tree grows towards the light. Tree species react differently to the reduction of light, depending on their light demands and their shade tolerance, but lack of light always leads to root reduction (Bernatzky, 1978).

In regards to the shade tolerance of tree species, Henry Horn (1971) found that tree species with leaves arranged in multiple layers, such as Aspen, Birch and Silver Maple, grow fast in full light, admit a large percentage of light to the ground and are not tolerant of shade. Tree species with leaves arranged in a single layer, such as the Norway Maple and Horsechestnut grow more slowly, cast a denser shade and are more shade tolerant than species with a multi-layer crown. This suggests that trees such as the Norway Maple grow better than most in shade; however, they have the disadvantage of creating the densest shade where it is least desired. Trees which naturally grow beneath the canopy of larger trees, such as the Redbud, are not large enough to be effective shade trees in cities, although they are shade tolerant. Arnold (1980) concludes that there are no desirable shade tree types which will dependably grow in locations that receive less than three hours of direct sunlight daily during the growing season.

Two other factors are important when evaluating the amount and intensity of natural light in a small area. The first is the reflectivity of various landscape and architectural surfaces. Smooth-textured, light-colored surfaces such as snow, white plaster, concrete, and, more recently, mirrored glass reflect a large percentage of the available solar radiation. Plants with thin-leaf surfaces, thin or dark bark (such as the Sugar Maple and Mountain Ash) are especially prone to leaf scorch, sunscald and thermal stress when subjected to intense amounts of reflected light. Consideration must be also given to the aspect (orientation) and slope of the planting site. Since most city centers are relatively flat, aspect is usually more important than slope. However, in suburban areas and along highways both factors can be important. Steep south or southwest-facing slopes are hot and dry because of their favorable angle of incidence to summer sun. North-facing slopes are cooler and moist. Therefore, to grow vegetation successfully on hot, dry south-facing slopes, either select drought-tolerant plants or provide adequate irrigation. These restrictions are less severe where the planting site is on north-facing slopes.

For the reasons explained above, if natural light conditions at the site are diminished by shading from vegetation or buildings or intensified by reflected light or slope, make a note of the condition on the base map.

Wind. Strong and turbulent winds occur in specific areas as a result of modifications of the airflow pattern by existing vegetation and structures. A common occurrence is an increase in wind velocity as a result of air passing through a narrow opening between buildings. This channeling effect is exemplified by the strong winds blowing down city streets bounded by large, tall structures. When accompanied by high temperatures and inadequate soil moisture, strong winds increase evapotranspiration and the likelihood of plant dehydration. Extreme winds can cause storm damage to trees. Weak-wooded species are especially susceptible to wind damage and can pose a hazard to property and persons. Tree species with strong, deep root systems should be selected for planting in areas with high winds. The root traits of selected tree species is included on the Tree Selection Matrix in the following chapter.

Occasional extreme winds or consistent strong winds can deform trees. Tree trunks bend with the prevailing wind, and the canopy becomes asymmetrical, with the branches flagging to the leeward. There is little substantive data on the relative ability of tree species to maintain an upright symmetrical form when subjected to strong winds.

Because of the adverse effects high-speed winds can have on plant growth and form, areas where winds are frequently strong should be identified on the base map. Species tolerant to these conditions can then be selected.

Precipitation. Water is one of the critical factors related to plant survival. In many Interior Western areas, most precipitation falls during winter snowstorms. It is usually necessary to irrigate urban vegetation throughout the warm, dry months. When examining a specific proposed

planting site, note whether irrigation will be provided and if it will be provided in a quantity sufficient to meet the plant's needs. If irrigation is not provided, determine how much natural precipitation will reach the plant. Often this is not 100 percent of the requirement. For example, a tree located in the lee of a large building may be in its rain shadow. Therefore, it will not receive as much water as a tree to the windward. In general, trees that are not irrigated will only survive in soils with a high water holding capacity. Other factors that limit the available moisture are architectural overhangs and trees. These intercept precipitation and create dry spots below them. On the other hand, trees located near awnings and downspouts may receive large quantities of precipitation. If the soil is not well drained, the plant growth may be retarded (by insufficient aeration and in extreme cases, by root rot).

Snow, especially wet snow that falls when trees are in leaf, can be very damaging. Plant tolerance to snow weight varies with species. Conifers, with pliable branches and pyramidal form, easily shed the snow and are relatively resistant to snow damage. Of the deciduous trees, those with thin branches (Birch, Black Locust), weak wood (Weeping Willow, Box Elder), and narrow crotch angles (Silver Maple, Siberian Elm) are frequently damaged by heavy snow loads.

The shapes of buildings affect snow loading and deposition in a small area, especially in conjunction with the wind. Melting snow frequently slides off pitched roofs and awnings onto trees and shrubs below. Snow drifts that accumulate to the leeward of buildings and trees can become maintenance problems. They also can bury plants, making them subject to damage by the unwary snow removal crew. However, a thick layer of snow over the root zone of trees acts as an insulator and reduces the depth of frost penetration. This can reduce root damage due to extremely low winter temperatures.

Because of the importance of moisture to plant growth in the semi-arid Interior West, examine carefully the precipitation available to plants at a given site. In addition, consider the positive and negative aspects of snow deposition. A list of selected "utility trees" that withstand the most adverse environmental conditions and thrive even though neglected is presented in Appendix C.

Lighting Evaluation

In recent years there has been a marked increase in the use of artificial lighting to accentuate designs, prolong their time of use and reduce vandalism. Artificial lighting has a definite impact on landscape plantings. The consensus among researchers is that intense lighting is potentially hazardous to woody plants and that even minimal lighting affects photoperiodic responses in both herbaceous and woody plants.

Supplemental lighting delays the onset of dormancy in the late summer and fall. Plants that have not hardened-off are susceptible to frost damage. One researcher reports that "most types of artificial light extend growth in plants, while lamps that emit red radiation may induce photoperiodic responses and retard growth. The cumulative effects of night-lighting may be unbalanced growth, irregular flowering and delayed dormancy. Some early breaking of dormancy may also be expected in sensitive species, thus increasing danger of dieback in spring as well as early winter . . . Deciduous trees are more sensitive to extra light than evergreens" (Quigley, 1979, p. 41).

Much remains to be learned about how woody plants respond to photoperiod, wavelength and the level of supplemental light. A list of the relative sensitivity of selected trees to security lighting is presented in Appendix C-8. The following design alternatives, excerpted from "Lighting the Landscape" (Quigley, 1979), may be implemented to minimize the impact of artificial lighting on plant processes.

Selection of lamp type. High Pressure Sodium (HPS) lamps should be used where high visibility on streets and freeways is required and where only light-tolerant plants would be used. Although less efficient than HPS lamps, metal halide lamps are preferred in malls, parks and residential areas where dense plantings are desired and where color rendering of plants, people and buildings would be effective.

Shielding. The least expensive lamps often emit light in a 180 arc under the lamp. Covering lenses or shields can sometimes be used to direct the light to the street or pavement and away from plants. More elaborate fixtures have additional built-in shielding to focus or direct light in specific patterns.

Installation and maintenance programs. New plantings can be installed in either spring or fall. In order to slow growth and allow for hardening-off during this period and during subsequent years, the frequency of watering and the level of fertilization should be reduced. Maintenance programs during the first years of growth can greatly help to reduce the sensitivity of the plants to lighting, as well as to heat, cold, drought, air pollution and salt injury.

Careful placement of street lights, path lights and floodlights should minimize their undesirable influence on all but the most sensitive species.

Where foliage interferes (or will interfere when the plant matures) with good light distribution and optimum visibility, lamps or vegetation are almost certainly misplaced. Minimum canopy height for street trees is regulated by ordinance in many municipalities.

Planting Site Constraints

Soil characteristics, distance from road and building edges and overhead and underground utilities all provide physical constraints to the selection and arrangement of shade trees. The site evaluation process should include an analysis of these factors, which may limit alternatives when the design phase begins.

Soil requirements for root growth. Restricted space for root development is the most severe limitation for tree growth. Urban soils are generally quite poor in texture, sterile and compacted. They are also subject to drought and pollution from animal excreta. Poor soil fertility, texture, and structure reduce growth rates and stunt trees. Limited root space further compromises tree vitality.

The root system a tree develops is, to a large extent, a response to the local soil. In sandy, well-drained soils trees will develop deeper root systems than they will in soils with a hard-pack or clay layer near the soil surface. However, because a root system needs air and water to grow, most feeder roots lie within the top four feet of the soil. It is commonly believed that a large shade tree requires an absolute minimum root space that is four to five feet deep and 12 to 15 feet in diameter. However, the roots of large trees can occupy areas 1-2 times the size of their crowns, often extending 2 to 3 times the diameter of the canopy from the trunk if unrestricted. Arnold (1980) writes:

> A four foot deep, 12 feet by 12 feet square area of prepared planting soil provides 21.3 cubic yards of optimum root growth space. Less than this amount of good soil will restrict growth of large shade trees, slowing their later growth rate and limiting their ultimate size. When the root zone is reduced to eight feet by eight feet (only 9.5 cubic yards), the root system of a large shade tree becomes too restricted for normal growth. Under the best of these conditions, the tree may grow to a small size at maturity and may decline in health thereafter. Increasing the soil depth beyond five feet does not compensate for reduced horizontal root spread. (p. 128)

Urban (1989) notes that a 25' caliper tree requires 1000-1200 cubic feet of rooting volume, anything less and the tree will be smaller and often weaker (Figure 8-6).

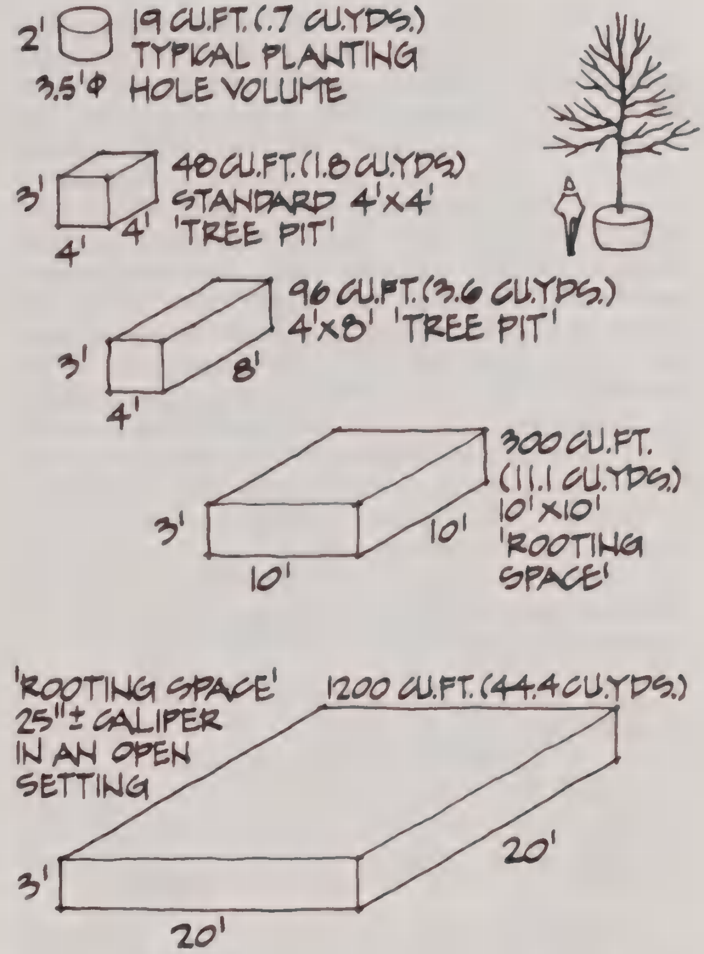

Figure 8-6. The volumes here represent the rooting space given urban trees under different conditions. To grow a tree 25 inches in diameter, more than 1,000 cubic feet (37 cu yards) of rooting space is needed. The roots of a tree 4 inches in diameter will fill a 4-foot-by-4-foot pit in less than four years. Moll and Urban, American Foresty Association, P.O. Box 2000, Washington D.C. 20013

The quantity and quality of the rooting medium is critical. Soil on each site should be carefully analyzed. Refer to the quick reference guide to soil assessment at the end of Chapter XI. If it is of poor quality, it means that a larger hole will be required and more backfill used than would be needed for good quality natural soil. In suburban areas the native soils in their uncompacted natural profile usually provide an acceptable medium for root growth. In this case, the standard practice for transplanting trees can be followed: provide a small pocket of good growing medium to help the transplant get established.

Distance from roads, walks and buildings. The width and location of the proposed planting site in relation to existing or proposed roads, walks and buildings is a determinant of plant selection and composition. Therefore, it is important to analyze the constraints these landscape elements will impose upon the design.

Narrow planting strips preclude using large trees and developing informal compositions. Large trees planted in narrow planting strips can heave and deform adjacent paved surfaces as the tree trunk expands. Sidewalk damage was a major concern of virtually all urban foresters responding to the questionnaire and was cited as a principle reason for public opposition to tree planting. The irregular walking surfaces pose an unnecessary hazard to pedestrians and a liability to the city. As a rule of thumb, planting strips should be at least seven feet wide where large trees are to be planted. Smaller trees should be used in planting strips narrower than this. Do not plant trees in strip's narrower than 4 feet. Choose trees which have "deeper growing" roots. It is also possible to modify soil texture in the planting strip to construct barriers and keep roots away from the sidewalk. The National Arbor Day Foundation recently published an article discussing options available in dealing with street tree-sidewalk conflicts.

Also consider the ultimate crown diameter of the proposed tree in relation to the distance from the planting spot to adjacent structures. Avoid selecting a tree that will eventually require constant pruning to keep it from contacting the structure. Consider using upright, columnar, fasigate, or globe forms or larger standard tree species.

Cross sections of six typical types of planting areas along the streets of cities in Utah and Idaho are shown below in Figure 8-7. The exact dimensions of each element will vary, depending upon city and subdivision regulations controlling

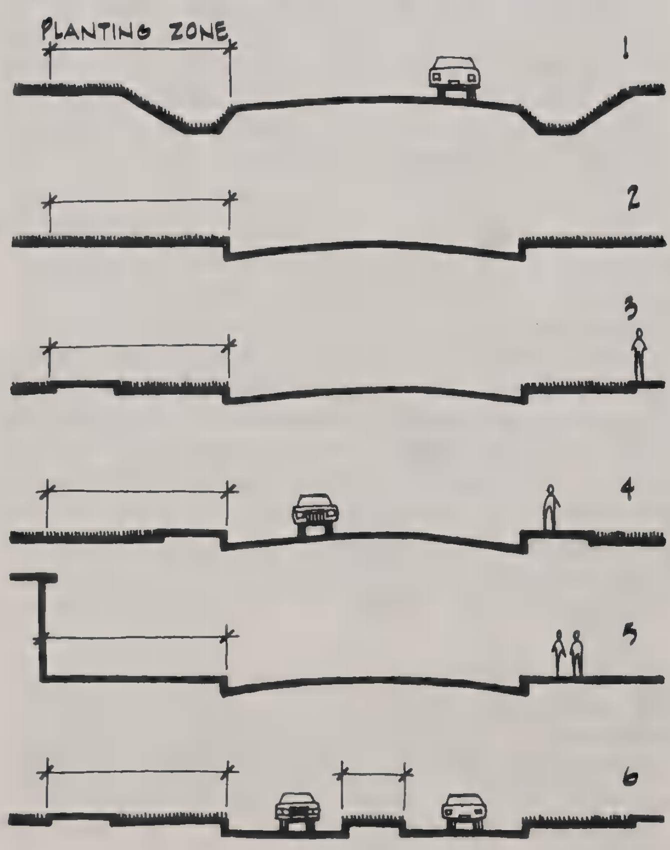

Figure 8-7. Cross Sections of Planting Situations

new development. The following discussion also identifies opportunities and constraints imposed by each cross-sectional type.

Type 1: road — planting strip — adjacent property. This configuration is typical of new subdivisions and residential areas within rural communities. Soil conditions are usually good except for pollution caused by runoff carrying deicing salts. This type imposes constraints and expect some tree damage caused by errant vehicles and snow-removal equipment.

Type 2: road — curb and gutter — adjacent property. This is very similar to Type 1, the major difference being that the curb provides a definite boundary between vehicular and pedestrian use areas. Large trees planted near the curb create a desirable scale and visual continuity. They are relatively well protected from mechanical injury from automobiles and snow plows and from chemical injury caused by polluted runoff.

Type 3: road — curb and gutter — planting strip — sidewalk — adjacent property. Type 3 cross section is most prevalent in older residential areas where the front lawn lies between the home and the sidewalk. In this situation trees are usually placed within the planting strip, rather than behind the sidewalk. This has aesthetic benefits, the most obvious being the effect of their canopies on the overall street scale formed by the canopy. Another benefit is that trees near the curb separate pedestrians from vehicles physically, visually, and psychologically. This configuration offers more safety to the pedestrian. The trees also shade the road and sidewalk. Despite these benefits, the frequent location of overhead utilities in this area and the width of the planting strip impose constraints upon plant selection. Another factor to consider is the height from the ground to the bottom of the canopy. If trucks will be using the road, at least 15 feet of clearance between the road surface and tree branches is necessary.

Type 4: road — curb and gutter — sidewalk— planting strip easement — adjacent property. This configuration imposes few constraints on plant selection and arrangement. Soil conditions are generally adequate and if the right-of-way is wide, there should be no conflict between foliage and overhead wires. The disadvantage of Type 4 is that the trees do not separate vehicles from the pedestrian use area. Pedestrians walking next to the road are subject to mud splash, noise and fumes from passing vehicles. Trees planted away from the curb are not as effective at creating visual continuity by arching over the road as those planted close to the curb.

Type 5: road — curb and gutter — sidewalk— building. This configuration is characteristic of most city centers, where commercial buildings are

set close to the street. Arnold (1980) makes a strong case for the use of closely spaced large shade trees, even in narrow streets and close to buildings. He cites the examples of pure forest stands, where trees take a different form than the lone specimen but still grow healthily in close quarters. Arnold maintains that trees planted very close to buildings will either grow away from the building toward the light or will naturally form an asymmetrical crown where the building and tree interface. Trees do respond as Arnold describes; however, there are other pertinent considerations. From an aesthetic point of view, many people object to the fence-row effect created by closely-spaced trees. Merchants often express concerns about trees closely spaced limiting visibility of signs and displays. Also, it is very difficult to paint or wash exterior wall and window surfaces when large trees are within inches of the building wall.

Another problem frequently encountered with this type of site is damage to tree roots from soil compaction. Heavy pedestrian traffic over the root zone is the primary cause. The best way to protect tree roots in areas of light traffic with a turf ground cover is to lay the sod over structural matting or open cell block. This disperses the weight load over a large area and prevents damage to tree roots. When pedestrian traffic is moderate, the conventional practice of laying paving stones or bricks in a sand bed on top of the root zone (as is typical in most European cities) is acceptable. Tree planting in areas of continuous pavement requires special design detailing and is discussed in detail in Chapter IX.

Conflicts with underground and overhead utilities can be a problem. The integration of the street tree and street lighting is especially important in this situation. The impacts of street lighting on plant growth have already been discussed. The spacing of trees should be planned in relation to the spacing of light. In plantings within the business district, street furniture (such as planter boxes, trash receptacles, benches and information booths) should also be positioned in accord with tree location. Generally, these landscape elements receive heavy use; thus, trees located near them may need some protection from mechanical and root injury.

Type 6: road — median strip — road. The median strip is not common in this region but is found in some cities. Where it does exist, the median provides an excellent opportunity to plant a unifying tree canopy over the entire street. There are, however, some limitations. Such strips are typically narrow and soil conditions less than optimal. Soil is often extremely compacted during road construction. High concentration of road salts is common. Clearance for vehicles is essential.

Trees planted in the median must be pruned to branch at least 15 feet above the ground for vehicle clearance on both sides. They should be tolerant of road salts. Trees should be the same size or smaller than trees on the opposite side of the street. Use of the same species is recommended.

Utilities. It is unfortunate that trees and overhead wires are often placed in the same right-of-way area next to the street. For both to co-exist, large trees must be pruned frequently to keep branches and wires apart and to minimize electrical hazard. Utility lines are easily broken by falling limbs. If the broken line falls within the reach of vehicles or pedestrians, it poses a serious hazard. Open, uninsulated wires in contact with tree limbs may burn the tree and can conduct electricity to the ground. Trees must be pruned so that utility personnel have access to utility lines, but this does not mean that trees need to be topped. Virtually every person responding to the questionnaire regarded topping as an undesirable practice. Topping, in fact, perpetuates the problem. For every branch pruned today, there will be ten or more weakly connected branches to prune in one to three years. Proper pruning technique can minimize repruning and its associated costs as well as enhance the aesthetic quality of the streetscape. In short avoid topping!

Coordination between the Shade Tree Commission and the local utility is essential when selecting trees. In most cases, pick trees that will not grow into the wires. The aesthetic benefits of large trees are significant. Those cities having sufficient money budgeted for tree maintenance can afford to prune large trees for utility clearance. This is money well spent because such trees make an important contribution to the visual quality of the city. Most cities, however, have little or no funds available for periodic pruning and tree removal. If you operate with a limited budget, consult with local utility officials and plant small trees below power lines. The person responsible for tree care may even develop a cooperative replacement program and eventually eliminate utility pruning by gradually replacing every third or fifth large problem tree with a smaller tree. This phased approach to tree replacement reduces resident complaints about losing their trees and stretches the maintenance budget. In 5 to 10 years there will be little pruning to be done. Working with local utility officials benefits everyone: tree problems can be avoided, proper trimming reduces the pruning cycle, and thus pruning costs, and the trees are less stressed and can contribute to the visual quality of the city.

Underground utilities restrict the space available for root development. They can also be damaged by growing root systems. Most underground utility corridors contain lines for water, sewer, gas, electric and sometimes television and telephone. Usually the lines are placed under the

road, although some are found in the adjacent right-of-way. Encourage utility companies to locate lines at the edge of the right-of-way when they are installing or replacing lines. Trees can be placed so as to avoid conflicts with the lines. If utility lines are four feet or more below ground, they are seldom damaged by growing roots. However, it is advisable to keep trees away from the space directly over the lines so that the lines are accessible in the future. Again, it is important that the Shade Tree Commission work closely with the utilities to plan utility installations that will still leave room for shade trees.

Figure 8-8. With cooperation, many utility corridors may become well managed greenways for recreation and wildlife

The purpose of evaluating the physical and biological factors previously discussed is to insure that the tree eventually selected for a given site will have a good chance of surviving. The high costs associated with the removal, maintenance and replacement of street trees require that new plantings be carefully planned to minimize future costs. Time invested in thoroughly evaluating these factors is well spent if it helps to insure the survival of each tree planted.

Functional Evaluations

An evaluation of the project site's physical and biological factors will identify the existence and location of environmental conditions not conducive to plant growth. In many instances, these same conditions make the environment unpleasant for humans and other living things. Extremes of temperature and solar radiation are examples of physical factors that can be detrimental to people as well as plant life. Plants can improve the environmental quality of the site. The following section describes an evaluation process for identifying the functional uses proposed plantings should have in relation to the environmental conditions of the site. It also provides lists of plants whose characteristics make them most appropriate for a given functional use. As was the case with the previous evaluation, relevant information should be recorded on a base map during a visit to the site.

Local Climate and Microclimate Control Needs

Vegetation is particularly effective in reducing the heating effect of intense sunlight. In evaluating a site to be planted, determine whether or not shading is desired and, if so, where, and at what times of the day. Overheating is severe in areas with extensive amounts of hard surface and south and western exposures. Parking lots, wide streets and other large paved areas are typical places where shade can provide welcome relief on a hot day. Shade trees should be located in these types of places. Trees with dense canopies block significantly more solar radiation than those with thin canopies. They provide the most relief in very warm areas. A list of selected trees with dense, average, and open canopies is presented in Appendix C.

In residential areas, trees planted to cast shade onto streets are desirable. They can also be used to reduce energy costs for space cooling. However, trees planted for this purpose must be relatively close to the home. Most street trees are too far from the structure to block the sun during the summer, but the property owner should be encouraged to plant trees for solar control. Shade trees incorporated in the design of parks, playgrounds, school grounds and other public open spaces make such places cooler and more attractive.

A number of cities in the Interior West have implemented or are in the process of implementing solar access ordinances. The purpose of a solar ordinance is to insure year-round sunlight to solar collector systems. It is the city or the property owner's responsibility to keep trees from obstructing the solar collection system. If a tree becomes an obstruction after the solar system is installed, it must be pruned by the person or municipality responsible for the tree. It is the responsibility of the individual installing the solar system to avoid locating it where an existing tree will shade it. Communities should be aware that conflicts between street trees and solar access present new types of problems. The consequences of solar access legislation on street tree ordinances have not been thoroughly explored and documented. It is advisable to consider the constraints solar access ordinances will have on street tree selection and location if solar access legislation is likely to be implemented in your community.

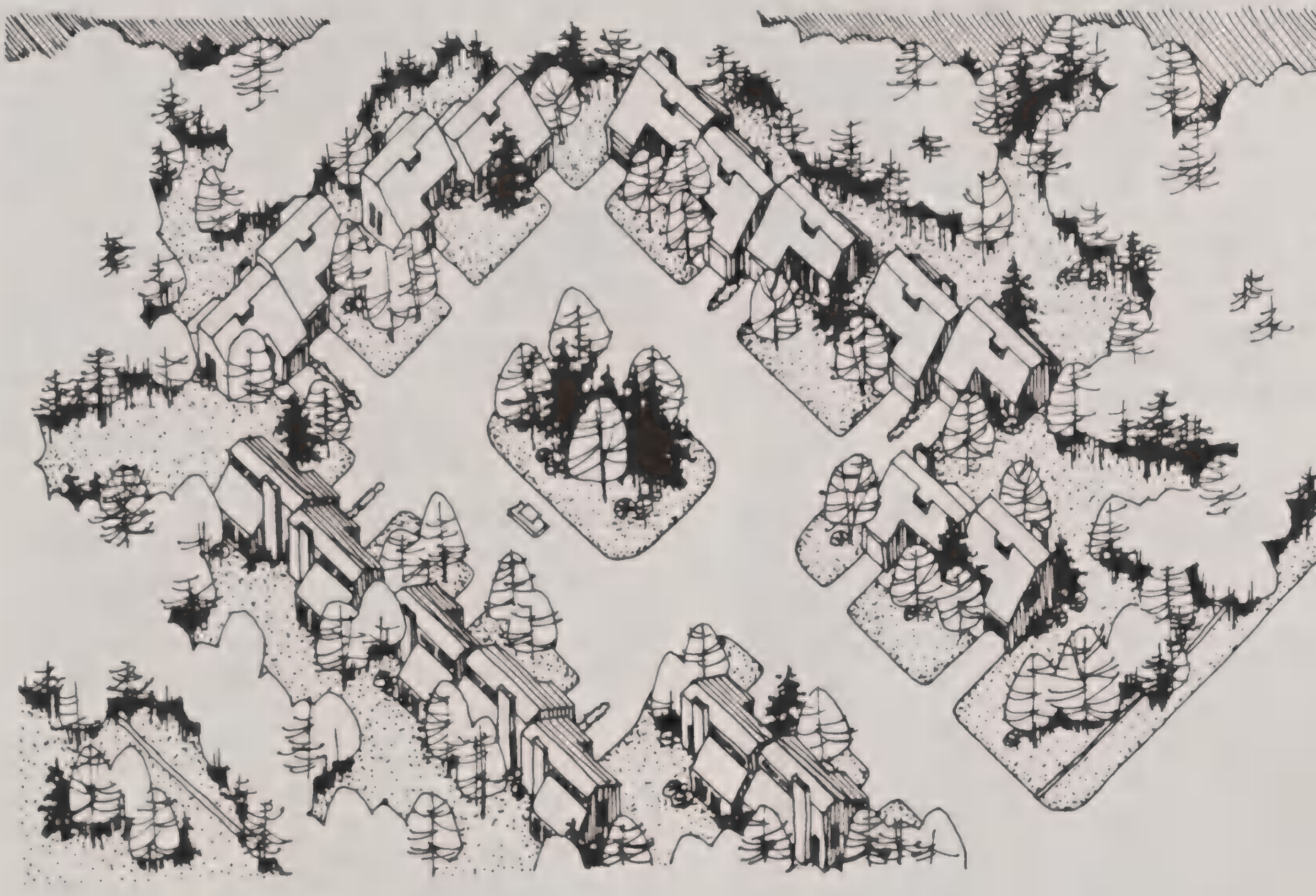

Figure 8-9. Trees Retained and Planted for Residential Climate Control and Other Functional Uses

The use of vegetation for wind control is more limited than it is for solar control. This is due to the fact that there is seldom enough space in cities to plant extensive windbreaks. Where space is a constraint, fences, walls or other architectural features can be used more effectively than vegetation for wind control. Also, conifers, which make the best windbreaks, are among the plants least tolerant of the air and soil pollutants commonly found in cities. Small areas within the city that are adversely affected by winds should be identified and mapped. Planting should be designed to avoid accentuating these problem areas. Trees arranged in a linear fashion will channel and increase wind velocity. Trees of varying heights, more randomly arranged, will reduce wind velocities.

In low-density residential areas there is often enough planting space to use windbreaks to reduce heating costs. However, in most cases this application depends upon the preferences of the homeowner and not the city. Several small towns in North and South Dakota have created large wind control plantations. These forests act as a greenbelt around the city. They help block undesirable winds and snow drifting in the winter and channel desired breezes into the city in the summer. However, the costs of acquiring land and managing such plantations are often prohibitive. A feasible alternative is to plan windbreaks is along highways bordering residential areas. Here, a dense planting of conifers can protect motorists from wind gusts, reduce snow drifting and highway maintenance costs, provide an effective visual screen, and help reduce noise levels. Plants well adapted for use in windbreaks are listed in Appendix C-10. More information on windbreaks can be obtained from one of the local Soil Conservation Service Offices listed in Appendix A.

Screening Needs

Unsightly views detract from the visual quality of many urban environments. When analyzing a proposed planting site, determine whether it is possible to screen the unpleasant ones such as parking lots, service areas, junkyards and industrial facilities.

If space is not at a premium, then vegetation is a possible screening solution. If there is very little space adjacent to the area to be screened, or an "instant" screen is needed, then a fence or wall

is a better choice. Evergreens make the best vegetation screen because they maintain their foliage year round and their foliage extends low to the ground. The individual plants should be spaced close enough together to form a solid surface in 5 to 10 years. If a more immediate screening effect is desired, the plants can be either larger at the time of planting, or spaced closer together. However, to maintain screening, plants must be removed to allow the remaining plants to keep their lower branches alive. Figure 8-10 illustrates how trees can be used to screen a parking lot. A list of selected plants suitable for screening is presented in Appendix C.

Figure 8-10. A Planting of Trees to Screen and Reduce Noise and Air Pollution

Noise Control Needs

While there is often a need for noise control in the city center, especially around spaces where people seek rest and relaxation, there is seldom enough space to locate the wide, dense plantings required to reduce high noise levels. This is particularly true along streets in commercial areas. Noise control plantings are more feasible along the periphery of parks, golf courses, and other open space areas. Deciduous shrubs and taller conifers planted along earth berms or walls are effective in these situations. One possible problem that may result from such a planting is that these dense plantings can provide concealment for muggers and vandals. In areas where crime and vandalism frequently occur, dense plantings for screening and noise abatement are not recommended.

Noise control plantings are not generally needed in residential areas unless homes are located adjacent to a high-noise source such as a major highway, a concrete plant, or other industrial facility. Noise control plantings along highway right-of-ways, if properly designed, can reduce noise from unacceptable to acceptable levels. Plantings for noise control should be located as close to the source of noise as possible and are more efficient if combined with mounding or fences. An example of a planting for noise abatement and screening around a parking lot is shown in Figure 8-11. Plantings around industrial facilities can provide additional benefits: screening the site, reducing particulate and gaseous air pollutants and abating noise.

Traffic Control Needs

Plants can be used to delineate automobile traffic routes in commercial and residential areas and in parking lots. Plantings can also help control pedestrian traffic by articulating space.

Along commercial and residential streets, Beatty (1977) suggests that a dominant tree specie be selected and planted uniformly along an entire street. The dominant specie delineates the street axis and creates visual harmony. Also, the planting of a single specie along a major street reflects the importance of the street. The street "reads" as an important thoroughfare in the city as a whole. Selecting different dominant trees for different streets will diversify species throughout the city without sacrificing unified effect which dominant trees establish on each street. Another approach — somewhat less visually dramatic but more ecologically sound — is to plant streets with different trees of similar size and form.

Trees can also be used to delineate major street intersections. For example the dominant tree along a street may be Norway Maple. The intersections may be delineated with a massing of small flowering trees such as the goldenrain trees. The motorist can see the goldenrain trees under the canopy of the Norway maples well before his vehicle reaches the intersection. This visual clue helps alert drivers to the location of intersections and may thus reduce the frequency of accidents. Care must be taken to locate delineator trees that branch close to the ground far enough away from the intersection so as not to block the view of oncoming drivers. Motorists at intersections should have at least a 75-foot horizontal sight distance. Trees that branch from 10 to 15 feet above the ground may be placed closer to the intersection than lower branching trees. An example of this type of planting is shown in Figure 8-11.

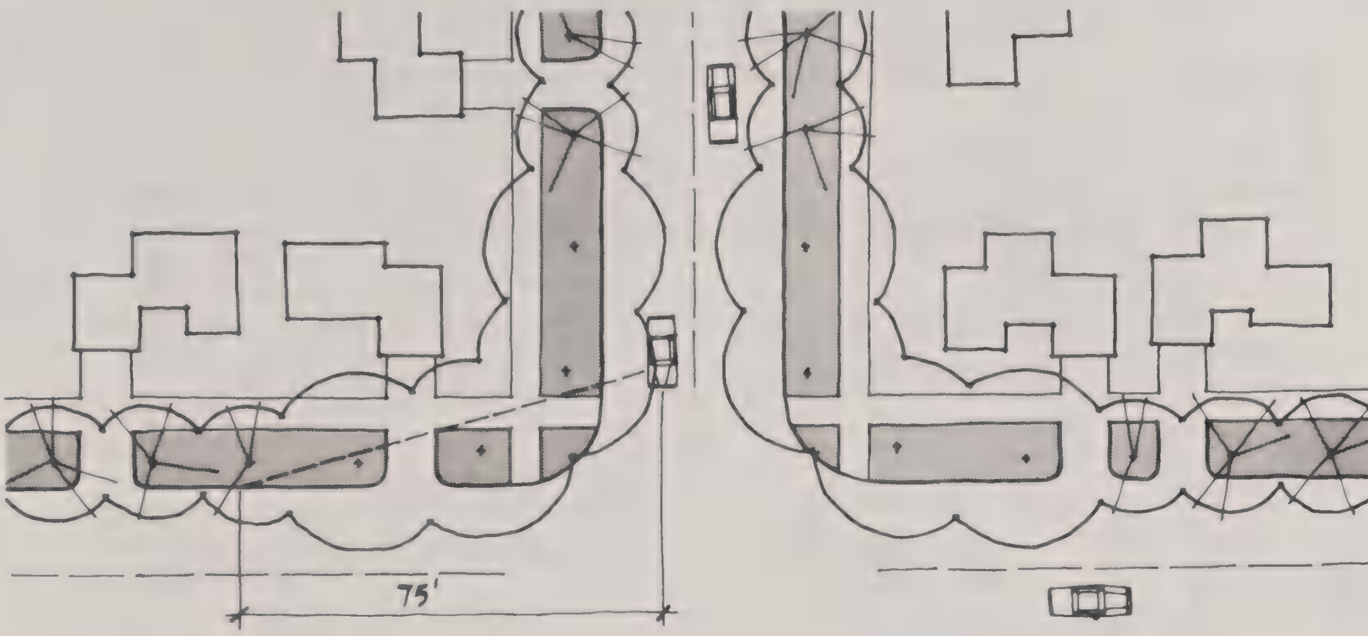

Figure 8-11. A Planting of Trees to Emphasize an Intersection and Allow a Safe Sightline

Beatty (1977) suggests three types of plants for parking lots: shade trees, emphatic or delineator trees, and screening or edge defining trees.

> The **shade trees** should have a rounded, high branched form and grow relatively quickly to cast a broad shadow.
>
> **Delineator trees** are used to guide traffic, signal highway entrances, terminate vistas and indicate ends of parking bays. They should be taller and more erect (pyramidal or ovoid forms) than the shade trees used; contrasting foliage color is also desirable.
>
> **Screening trees** may be smaller in size than shade or delineator trees. Both round and erect forms are appropriate. Low branching is important if sufficient planting space is available. Evergreen trees afford year-round screening. Higher branching trees can be effectively used if they are combined with low shrubs. The canopy shadow tends to block the glare from cars thereby giving the illusion of screening. (Beatty, 1977, p. 35)

Figure 8-12 illustrates how these types of plants may be used in a parking lot. All trees used along streets and in parking lots should be fairly drought tolerant, able to withstand intense, reflected heat, and relatively resistant to air and soil pollutants. In addition, trees located adjacent to circulation routes should branch 15 feet above the ground. Low branching, conical trees, particularly conifers, should be avoided.

Erosion Control Needs

Many environmentally sensitive areas with steeply sloping topography are being developed in Interior West communities. Erosion control measures are often required on these sites. Plants may be used to prevent erosion in many areas: along highway cuts, on disturbed or reclaimed sites, along riparian corridors and on new construction sites. **It is important to identify areas devoid or sparsely vegetated where erosion of topsoil occurs.** Erosion control measures not only conserve this valuable resource, but also reduce the likelihood of mud and landslides on unstable slopes.

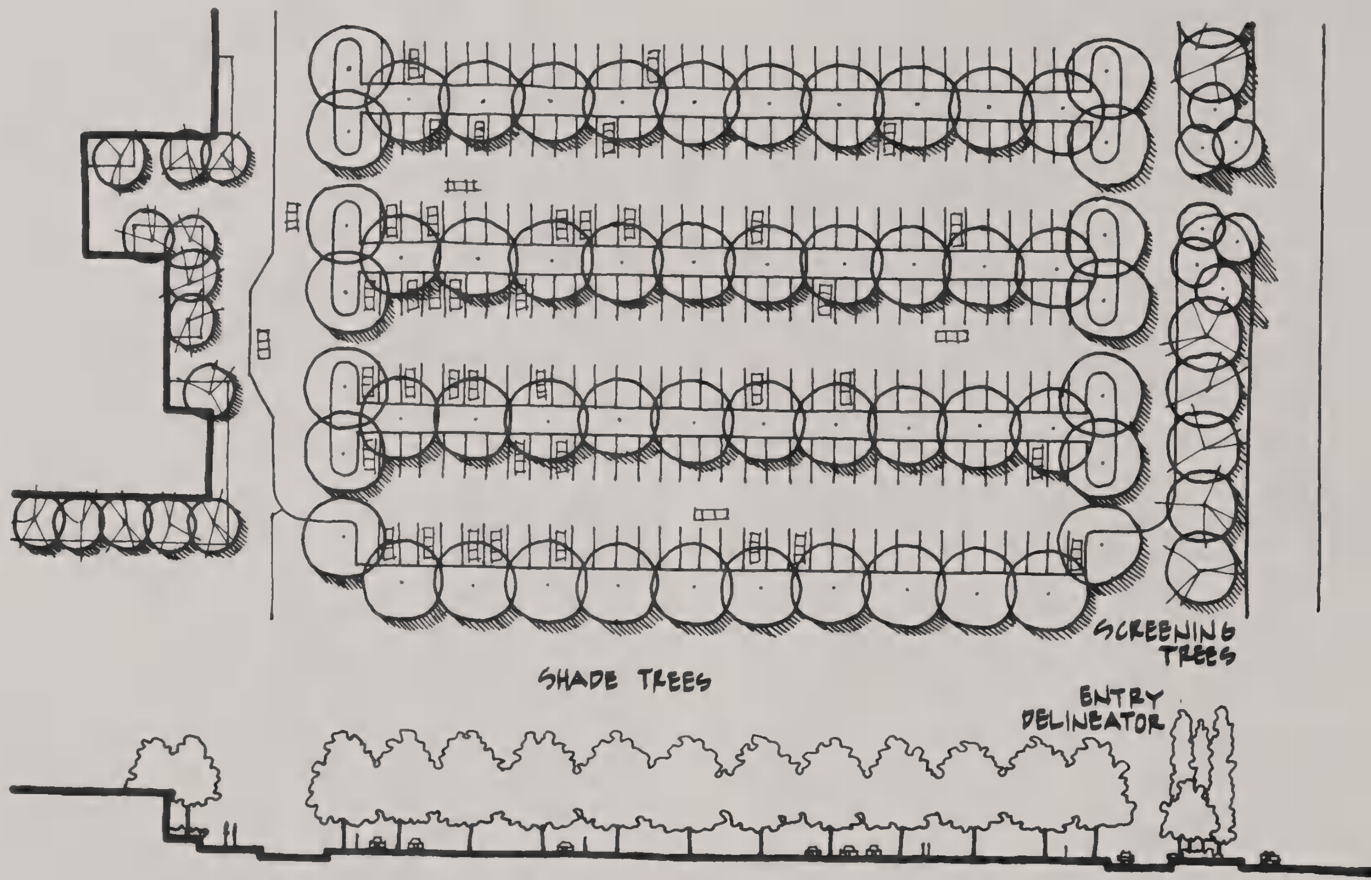

Figure 8-12 Trees Used to Screen, Shade, and Control Traffic

Plants are frequently used on city-owned lands to control erosion on new construction sites (parks, sand and gravel mines, etc.) and on steep slopes created by road construction. A diversified planting of trees, shrubs, ground covers, and grasses is recommended for plantings on steep slopes. Plantings should include species with different root types and rooting depths. On sites that are not steeply sloping, ground covers with a vigorous, shallow spreading root system should be used. The roots bind the soil particles together, and the foliage protects the surface of the soil from raindrops. Since many of these sites are not irrigated, drought-tolerant species are generally planted. A list of selected plant species useful for erosion control is presented in Appendix C.

A number of different engineering and revegetation methods can be employed to control erosion by revegetating steep slopes and hillsides. The method which will work best depends upon slope gradient and aspect, local geology, soil characteristics, amount of irrigation to be applied, local climate, proposed land uses and budget limitations. Each situation should be examined carefully by a professional familiar with the factors mentioned above and with the revegetation process.

Figure 8-13 Vegetation Used to Reduce Soil Erosion.

Wildlife Habitat Needs

Preservation and enhancement of wildlife habitat complements other goals that make a community interesting and more pleasant to live in. The following guidelines work in conjunction with community forestry measures that implement soil conservation, climate moderation, buffering and screening, noise control, and expansion of recreation opportunities. The potential to integrate wildlife habitat should be considered in all projects of all sizes and scales. Special potential exists in

public open spaces, such as river green belts, parks, golf courses, and schools.

Wildlife are only able to live in places which meet their needs for food, water, protective cover, space, and movement. Since most wildlife species are dependent either directly or indirectly on vegetation for their survival, the planning and management practices carried out by urban foresters can have a pronounced impact on the presence, diversity, existence, and well-being of wildlife. The following guidelines can assist planners in incorporating living spaces for wildlife into the urban forest.

> "Dear little tree that we plant today, what will you be when we're old and gray?"
>
> "The savings bank of the squirrel and mouse, For the robin and wren an apartment house."
>
> "The dressing room of the butterfly's ball, The locust's and katydid's concert hall."
>
> "The school boy's ladder in pleasant June, The school girl's tent in the July noon."
>
> "And my leaves shall whisper right merrily, A tale of children who planted me."
>
> --*Author Unknown*

Any planned wildlife habitat areas, or patches of habitat in existing urban open spaces, should be made as large as possible. The optimal shape is curvilinear and irregular, rather than rectilinear. Large, circular areas are best planted with few tree and shrub species in the interior, and many shrub, grass, and perennial forb species at the edge. Undulating, irregular edges are more desirable than straight edges.

Heterogeneity is the key for selecting and arranging plant materials. Choose a variety of species, sizes, and ages of plants. Clump plants of the same species together, rather than scattering them as individuals. Reduce mown lawn areas, and explore the possibilities of planting native grasses and ground covers. Retain dead trees in naturalistic plantings: one snag per 1/4 acre is optimum (Cerulean, 1986).

When selecting plants, choose those that provide resources for wildlife. Wildlife naturally are sustained by native plants, and natives are best adapted to local site conditions. Select and arrange plants to provide year-round food and cover: a mix of deciduous and evergreen trees, shrubs, and ground covers that has a range of foliage and branch densities and that bears seeds, fruits, berries, or nuts.

Preserve any unique features on the site, especially patches of undisturbed native vegetation, water, and areas of topographic variation.

An aspect of wildlife requirements most often overlooked by planners is an animal's need to move. An area of wildlife habitat is most valuable when it is linked with a continuous network of open space vegetation. As habitat areas become smaller and more isolated due to suburban growth, it becomes increasingly more important to provide continuous animal movement corridors that allow wildlife to move between different areas.

Measures must be initiated to ensure that the condition of urban vegetation remains supportive of wildlife. It is necessary to consider a different approach to maintenance of urban wildlife habitat areas, because the methods of achieving structural diversity of vegetation differ from those that result in a manicured appearance.

Do not disturb dead trees and branches, downed wood, or leaf litter except as necessary for

public safety. Retain natural grassland areas, drainages, and wetlands. Eliminate or moderate the use of chemical pesticides. Seek input from state or local wildlife specialists on all projects, and exploit every opportunity to encourage wildlife to share your city.

Air Quality Improvement Needs

The mechanisms by which plants improve air quality have been discussed. Few cities can afford the luxury of planting trees solely for the purpose of improving air quality, but fortunately trees should and do fulfill a number of aesthetic and functional roles simultaneously. Identify areas with low air quality. This knowledge will be useful in selecting trees that are tolerant of air pollutants for planting in affected areas. It also suggests that larger plantings of resistant species are needed if air quality improvement is a goal.

Air quality is generally the poorest in the "canyons" of large cities and at major intersections, where the high concentrations of automobile exhaust emitted in large quantities by idling cars is confined by tall buildings. Areas downwind of power-generating stations and certain industrial facilities may also have high concentrations of gaseous pollutants. Plants suitable for use in areas where high concentrations of air pollutants exist are listed in Appendix C.

Planting and Maintenance

In selecting trees for planting, the city forester may choose among hundreds of species and cultivars, each with its own set of unique characteristics. With this vast array of choices, how can he hope to select the right tree for a given location? This manual has presented a process that utilizes a host of aesthetic and functional criteria to reduce the number of possible choices down to those most suited to a specific project site. This process generally leaves the forester with a relatively short list of trees from which to choose. To arrive at the optimum choice, the forester must take several other factors into account.

Of particular importance is the cost of a planted tree. Figure 8-14 shows how the cost of a tree increases as the trunk caliper (diameter 12" above ground) increases. Small trees are most economical to plant; however, their crown volume, which is the best measure of the tree's visual impact, is small. It may be necessary to wait from 15 to 20 years for a fast growing tree to create a bold form. Small trees are also susceptible to damage from vandals, vehicles, and power mowers. The trunk caliper of trees to be transplanted should not be less than 3/4." Trees of this size are typically planted along residential streets throughout the region. If, as is the case with many urban center plantings, the goal is to create an immediate visual impact, there are three possible solutions: larger trees, more small trees, or a combination of large and small trees. With modern transplanting techniques, large trees (less than 30 feet tall) can be transplanted. However, the survival rate is less than that of smaller trees unless extreme care is provided. For an immediate visual impact, planting fewer large trees farther apart may be more economical than numerous small trees closely spaced.

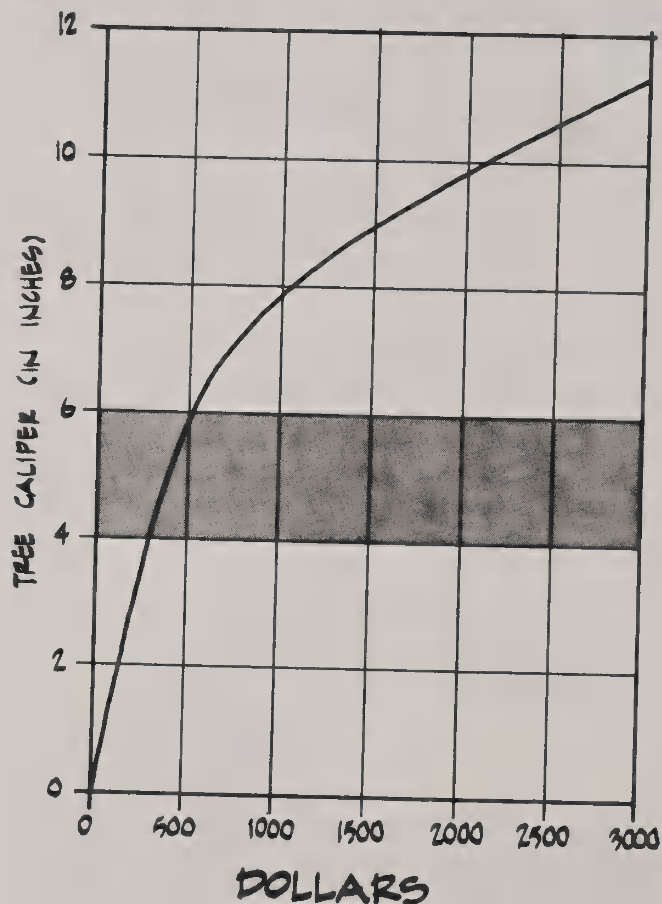

Figure 8-14 Cost of Planted Shade Trees Varies with Caliper. Trees with 4-6" Caliper Represent an Economical Size for Transplanting. Source: *Trees in Urban Design* (Arnold, 1980).

The growth rates of trees varies with species. Some trees, like the London Plane, grow rapidly after transplanting; whereas others, such as the Maples, grow slowly for five years due to transplant shock. Once established, though, they grow moderately fast. Trees like the Ginkgo always grow slowly. Growth rate becomes important when selecting tree species for planting and arrangement. Fast growing tree species need not be spaced as closely together as slow growers to achieve the desired visual impact five years after planting. This implies the need for fewer trees, which reduces costs.

The recommended spacing for 4" to 6" caliper trees (20 to 30 feet tall) is 30 to 40 feet on center. Generally, street trees spaced 40 feet apart will begin to provide a continuous canopy from 10 to 15 years after planting. If cost is not a limiting factor, closer plantings may be successfully used for some species. The Honey Locust, Ginkgo and Plane Tree, because of their sparse branching structure and open foliage, are more adaptable to different planting densities than trees such as the Horsechestnut and Littleleaf Linden.

Before selecting the most economical species that will thrive on the site and meet all the functional and aesthetic criteria the situation calls for, the municipal arborist should consider two other factors: availability and maintenance characteristics.

A number of good city trees are not available in large sizes and quantities in nurseries. This is due to the belief that they do not tolerate transplanting very well, or that they cost too much or to negative public perceptions of the tree. The Oaks are examples of the first case, while the Chinese Elm *(Ulmus parvifolia)* is typical of the latter. When the size of tree species is greater than four to five inches in caliper, the commercial supply declines sharply. In addition to this problem, a large quantity of a single tree-type is frequently not available. Because many good urban tree types are not produced by local nurseries, it may be necessary to locate and transport trees from distant nurseries. This problem may be alleviated by ordering trees a year or more in advance for a specific project. A city may wish to maintain its own transplant nursery, buying smaller trees and growing them the desired size.

Tree maintenance costs are hidden until the plant goes into the ground. Then, depending on the species and its location, they may remain hidden until the tree dies and must be removed, or they may continually haunt the municipal arborist. Most trees require some maintenance for optimum appearance; however, some trees create more problems than others. A list of the relative maintenance requirements of a variety of species is presented in Appendix C-13. The following criteria were used in evaluating each tree species: susceptibility to insects and diseases that require pruning or spraying, wood strength, littering of twigs, bark, leaves, flowers and fruit (both the quantity of litter and the time period over which littering occurs), propensity to sucker (i.e. pruning requirements) and propensity to reseed. Refer to the Tree Selection Matrix for an account of the specific maintenance problems associated with a particular tree species.

There is a need for informed judgement when selecting trees. The principal criteria have been outlined above. The process is logical and sequential, not arbitrary. It begins with an examination of the environmental conditions of the site to be planted. If there are similar areas in the city, visit them and look at the condition of the trees growing there. In most cities, there are relatively few trees that are growing well and do not require extensive maintenance. Tree species that have proven successful over the years are usually the best choice for any extensive new planting. Experiments with new species and varieties should be conducted only on small-scale projects where the loss of trees will not be costly or aesthetically ruinous. Information concerning new tree species and varieties can be best obtained from state arboretums and public gardens in the Interior Western States. In Utah and Idaho, the State Arboretum of Utah (Salt Lake City), the Idaho Arboretums (Moscow and Boise), the Utah State University Horticultural Station (Farmington, UT), and local nurseries. In Nevada, the campuses of the University of Nevada at both Las Vegas and Reno have designated State Arboreta and are open daily for tree viewing. Capitol Park in Sacramento is an excellent site for viewing large trees as well.

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IX. TREE SELECTION AND PLANTING

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- Tree Selection for Tree-Type Categories
- Tree Selection for Project Sites
- Tree Selection Matrix
  - Hardiness
  - Physical Characteristics
  - Habitat Requirements
  - Maintenance Characteristics
  - Ornamental Characteristics
- Planting Plan and Schedule
- Planting Specifications
- Staking Plan
- Ordering Plants
- On-Site Plant Inspection
- Planting Season
- Planting Techniques
  - Balled and Burlapped Trees
  - Container Grown Trees
  - Bare Root Trees
  - Planting in Pavement
  - Field Transplanting
- Anti-Transpirants
- Staking
  - Protection
  - Root Anchorage
  - Trunk Support
- Tree Wrapping
- Watering and Fertilizing

TREE SELECTION AND PLANTING

We have developed a Tree Selection Matrix to aid in selecting trees for the Community Forest. The Tree Selection Matrix is a screening device which allows the user to eliminate from consideration all those trees which do not have the required characteristics best suited for a particular site. The Matrix lists selected trees along the vertical axis and tree characteristics along the horizontal axis. Trees are arranged by size as large, medium, and small according to their character: formal, semi-formal, or informal. For each tree, 26 characteristics are listed. A more detailed description of these characteristics accompanies the Tree Selection Matrix at the end of this section. Following a description of tree selection techniques, the Manual offers recommendations for ordering, inspecting, planting, and caring for young trees in order to ensure that they establish and survive.

Tree Selection For Tree-Type Categories

The tree selection process begins with the development of a tree list for each Tree-Type Category specified on the Forest Plan Map. The purpose of the Tree-Type Categories is to directly associate tree size and character with planting pattern in a table form that serves as reference for all future planting decisions.

Planting pattern and character should be coordinated as discussed in the Forest Plan guidelines. Trees with formal or semi-formal character, regardless of size, should be selected for all formal plantings. Tree character is less important in informal or combination or wildlife planting patterns because much of the design effect is achieved by the placement of trees.

There are several steps involved in selecting trees for each Tree-Type Category. First, review the Forest Plan Map and note the Tree-Type Categories specified. Use each Tree-Type Category as a heading beneath which you will develop a list of trees. Second, refer to the Tree Selection Matrix. Begin your use of the matrix by looking at tree size (large, medium, small) and tree character (formal, semi-formal, informal). For each Tree-Type Category specified on the Forest Plan Map, make a list of trees with the following characteristics:

1. Appropriate tree character for each planting pattern specified on the plan.

2. Hardiness appropriate for the area.

3. Resistance to insect and disease problems and low maintenance requirements.

4. Special requirements such as salt tolerance, etc.

5. Tree species not already "overplanted".

For example, our hypothetical community, Grove City, Nebraska, specified large deciduous trees, a formal planting pattern, hardiness zone 1-3, and no insect, disease, or maintenance problems for all its trees along Main Street. They describe this as a Formal Large Tree-Type Category. The list of trees derived from the matrix for this Tree-Type Category would include the following trees:

Tree-Type Category:
Formal-Large

Trees: Required Characteristics — Large, formal or semi-formal, hardiness zone 1-3, insect and disease resistant, low maintenance.

Acer platanoides and *cultivars*
Acer rubrum
Fagus sylvatica
Liquidamber styraciflua
Liriodendron tulipifera
Platanus acerifolia

Tilia cordata
Zelkova serrata
Celtis occidentalis
Fraxinus pennsylvanica and *cultivars*
Ginkgo biloba
Gleditsia triacanthos inermis and cultivars
Glymnocladus dioicus
Quercus alba
Quercus robur
Quercus rubra
Tilia americana
Tilia euchlora 'Redmond'

All the other large trees on the matrix were eliminated because they failed to meet one of more of the required characteristics.

The list of trees for each Tree-Type Category will become the list from which all the trees in the community forest will be selected. This list should be periodically reviewed, adding new selections or cultivars and eliminating less hardy and overused trees. The selection of trees from the list of suitable species should respond to composition of species in the existing urban forest.

If the Community Forest Plan specifies Tree-Type Categories such as windbreaks, refer directly to the tree lists in Appendix C.

Tree Selection For Project Sites

Ultimately, the community forest planning process should lead to the selection of a variety of tree species, varieties or cultivars most suitable for a project site. The selection process will begin with the preparation of the tree list for each Tree-Type Category. Refinement of the list for each project site will follow a similar process and be based on the project site inventory, analysis and evaluation. The objective is to find trees with characteristics that meet the criteria specified in these detailed studies. Specifically, the trees must be:

1. Compatible with the aesthetic characteristics specified in the Forest Plan Report; characteristics used to develop the tree list for each Tree-Type Category.

2. Suitable for the biological conditions and physical limitations of the site (specifically soil, air quality, exposure, climate, lighting and planting site constraints).

3. Compatible with the specified secondary visual characteristics (specifically color, form, and texture).

4. Suitable for solving the functional needs associated with the project site (such as screening, control of climate, noise, traffic, erosion, and wildlife habitat).

5. Suitable for the extent of maintenance which can be provided (specifically insect and disease resistance, pruning needs, wood strength, life span, ease of transplanting, litter production, and rooting characteristics).

These criteria can be divided into two categories: primary and secondary. Primary criteria are those criteria which the selected tree species **must satisfy** if they are to survive and function successfully. These criteria include:

1. Trees specified in the Forest Plan Report (Tree-Type Categories)

2. All biological and physical criteria

3. Essential functional criteria

4. Maintenance characteristics

Secondary criteria are those things that **are desirable** in the tree species but **not essential** to a successful planting and include:

1. Preferred color and texture

2. Non-essential but desirable functional criteria

How does one go about choosing a tree species for a project site? Let's return to the Grove City example. The city plans to plant a two-block section of Main Street. In the Community Forest Plan Map for Grove City, the Shade Tree Commission in working with the parks and streets departments has recommended that large deciduous trees be planted along Main Street in a bold formal planting pattern. The Commission has already developed a list of trees for the Formal Large Tree-Type Category specified on the plan. The Commission's inventory and analysis of the project planting site indicated several additional primary criteria would be factors in tree selection including tolerance to alkaline soils, de-icing salts and soil compaction. The Commission would also like to plant a tree with yellow fall color and medium texture to complement the Green Ash trees nearby. In addition, a dense canopy that would provide heavy shade was specified to reduce mid-day temperatures in the area.

TREE TYPE TREE NAME	DESIRED CHARACTERISTICS								
DECIDUOUS TREES HARDY IN ZONE 1	PRIMARY						SECONDARY		
	HARDINESS ZONE 1	RESISTANT - INSECTS & DISEASE	LOW MAINTENANCE	TOLERANT - ALKALINE SOILS	TOLERANT - DE-ICING SALTS	TOLERANT - SOIL COMPACTION	YELLOW FALL COLOR	MEDIUM TEXTURE	DENSE CANOPY
LARGE FORMAL									
NORWAY MAPLE									
COLUMNAR NORWAY MAPLE									
CRIMSON KING NORWAY MAPLE									
RED MAPLE				N					
EUROPEAN BEECH				N	N				
TULIP TREE				N	N				
LONDON PLANE TREE					N				
LOMBARDY POPLAR			N						
LITTLELEAF LINDEN									
LARGE SEMI-FORMAL									
SYCAMORE MAPLE					N				
SUGAR MAPLE				N	N	N			
SILVER MAPLE			N	N					
COMMON HACKBERRY									
WHITE ASH									
GREEN ASH									
MARSHALL SEEDLESS GREEN ASH									
GINKGO									
THORNLESS HONEY LOCUST									
MORRAINE HONEY LOCUST									
SHADEMASTER HONEY LOCUST									
KENTUCKY COFFEE TREE					N				
BLACK WALNUT			N						
CAROLINA POPLAR			N						
FREMONT POPLAR			N						
BALM-OF-GILEAD			N						
WHITE OAK									
BUR OAK				N					
NORTHERN RED OAK						N			
BLACK LOCUST			N			N			
GLOBE NAVAHO WILLOW			N						
AMERICAN LINDEN									
REDMOND LINDEN									

Figure 9-1. Working Matrix 1

First, the Commission should make a list of all primary and secondary criteria for the project site. The list of primary criteria beyond those used in making the Tree-Type Category list would then include:

1. Tolerance to alkaline soils

2. Tolerance to de-icing salts

3. Tolerance to soil compaction

These additional criteria are primary and would have to be met by any tree selected. Secondary criteria would include:

1. Yellow fall color

2. Medium texture

3. Dense canopy

4. Minimal litter

Once the criteria list is completed, planners can either refer to the appended tree lists (Appendix C) for each of the additional primary criteria categories, noting those trees which appear on each of the tree lists, or they can refer to the Tree Selection Matrix. In our example, the Commission should refer to the Matrix.

Since the planting specified in the example is for large trees and a formal planting pattern, we need only be concerned with the trees in the Formal Large Tree-Type Category. Copy this list of trees to make a working matrix. On the horizontal axis list, the primary and secondary characteristics as shown in Figure 9-1. Refer to the matrix and go down the columns of primary characteristics. Check each tree for compliance with each of the primary criteria. Eliminate any trees that do not meet all the primary criteria.

After making these entries into the matrix, the list will be much smaller as shown in Figure 9-2. Repeat the process for the remaining trees on the list, working with the secondary characteristics.

TREE TYPE TREE NAME	DESIRED CHARACTERISTICS				
	PRIMARY	SECONDARY YELLOW FALL COLOR	MEDIUM TEXTURE	DENSE CANOPY	
LARGE FORMAL					
NORWAY MAPLE					
COLUMNAR NORWAY MAPLE					
CRIMSON KING NORWAY MAPLE		N			
LITTLELEAF LINDEN					
LARGE SEMI-FORMAL					
COMMON HACKBERRY				N	
WHITE ASH				N	
GREEN ASH				N	
MARSHALL SEEDLESS GREEN ASH				N	
GINKGO				N	
THORNLESS HONEY LOCUST			N	N	
MORRAINE HONEY LOCUST			N	N	
SHADEMASTER HONEY LOCUST			N	N	
WHITE OAK			N	N	
AMERICAN LINDEN				N	
REDMOND LINDEN				N	

* SPECIES MEETING ALL THE DESIRED CHARACTERISTICS

NORWAY MAPLE

COLUMNAR NORWAY MAPLE

LITTLELEAF LINDEN

Figure 9-2. Working Matrix 2

Using the Tree Selection Matrix in this example will leave Norway Maple, Columnar Norway Maple and Littleleaf Linden as the best choices for the project site. Each of these species meet all the project site criteria.

Although using the matrix will seem cumbersome at first, after several uses it will prove to be a simple and valuable technique.

Tree Selection Matrix

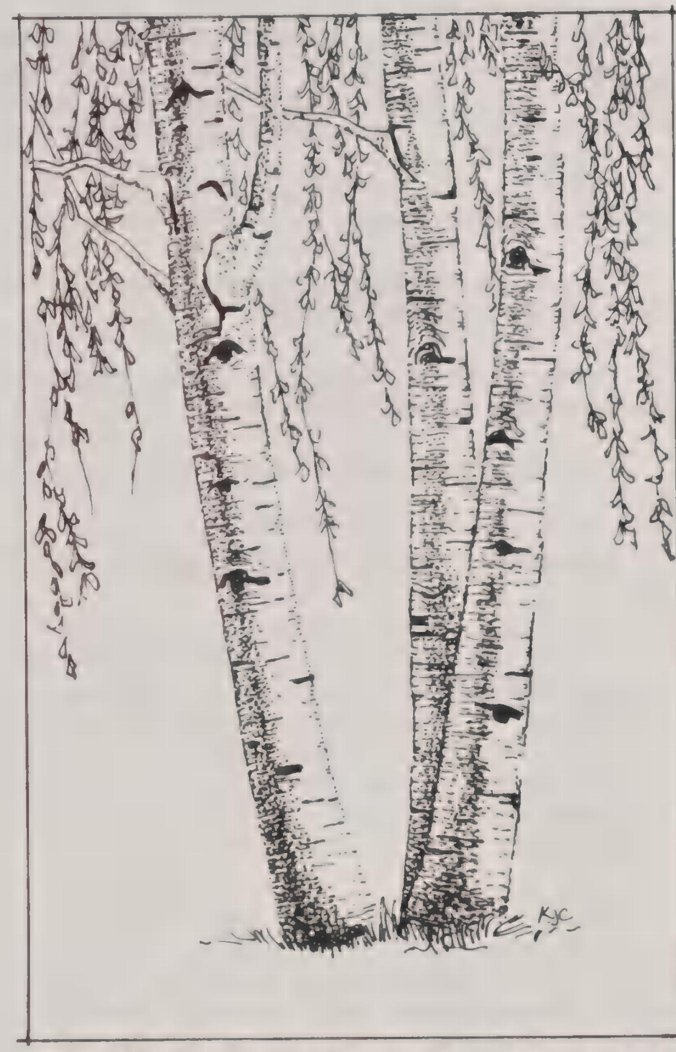
The Tree Selection Matrix contains twenty-six tree characteristic categories for common ornamental and shade trees of the Intermountain Area. The matrix is also useful in hardiness zones 1 to 4 throughout the Interior West. Similar lists can be readily generated by tree experts for all states in the Interior Western Region. Abbreviated tree lists for each of the Interior Western States can be found in Appendix B. The purpose of the matrix is to provide information useful in selecting trees best suited to given site conditions and design criteria.

The selection of tree species for the matrix is based upon the results of a survey conducted by Ken Brooks (1977) and a critical review by W. Richard Hildreth and Steve Schwab (1989). Questionnaires were sent to nineteen plant materials professionals. They evaluated 261 tree species for each of the following:

1. Tolerance to Intermountain climate or microclimatic conditions;
2. Plant availability in the Intermountain region;
3. Plant characteristics which serve aesthetic or utilitarian functions in the landscape.

In addition, the catalogs of five large Intermountain nurseries were surveyed to determine commercial availability of plant materials for the region.

Compilation of survey results took the form of a recommendation on the suitability of each tree for use in the Intermountain region. Most plants selected for use in the Tree Selection Matrix were recommended as highly suited for use. Several plants in the matrix were conditionally recommended. No plants were selected that were unsuited for use in the region. Plants suited to Zone 4 were selected based upon advice from nurserymen in the St. George area (Williams, 1981).



It should be noted that the list of trees contains some common cultivars and varieties. In practically every case, other cultivars and varieties of the species which have different characteristics are available. Space was left at the end of each grouping of trees to add new selections that are not included on the list.

Trees are first grouped according to mature height (large, medium, small). The trees within each height grouping are further subdivided into three tree character groups (formal, semi-formal, informal) and listed alphabetically by botanical name. Formal trees have a symmetrical or regular form. Informal trees are irregular or asymmetrical in form. Semi-formal trees have forms that may vary between formal and informal depending on age and cultural conditions that influence plant growth. Semi-formal trees may be integrated in either formal or informal designs, or may provide a transition between the two. Twenty-six tree characteristics are listed along the horizontal axis of the matrix. A brief description of each characteristic follows:

Hardiness

Cold hardiness is one of the first tree selection criteria to consider.

Hardiness zone. Hardiness ratings are based primarily on average annual minimum temperatures. Consult the Hardiness Zone Map in Chapter VIII to determine which zone your community is in.

Physical Characteristics

These include dimensional tree features that influence selection and location.

Form. Mature shape and growth pattern of the tree in an open location.

Height. Estimated average mature height in feet.

Spread. Estimated average mature spread in feet.

Height to canopy bottom. Estimated average height from the ground to the bottom of the canopy for unpruned trees. Low = 2'-8'; Ave. = 8'-12'; High = greater than 12'. Many evergreens (Fir, Spruce, Hemlock, and Arborvitae) look best and are found naturally with foliage to the ground.

Canopy density. Estimated percentage of available solar radiation transmitted through the canopy of the typical mature tree in full leaf based upon measurements and personal observation. Dense = less than 12% transmitted; Ave. = 12-20% transmitted; Open = greater than 20% transmitted.

Trunk size. Estimated average mature trunk diameter. Small = 2"-12"; Mod. = 12"-30"; Large = greater than 30".

Root habit. Self-explanatory. Root habit relates to transplanting difficulty in that trees with shallow fibrous roots are generally easier to transplant than those with taproots.

Rate of growth. Estimated growth in diameter per season after establishment given suitable conditions. Slow = less than 1"; Mod. 1"-2"; Rapid = greater than 2".

Longevity. Lifespan in years given a suitable environment. Short = less than 50 years; Mod. = 50-100 years; Long = greater than 100 years.

Habitat Requirements

These are important biological factors that influence plant growth. All habitat requirements except soil type are keyed as follows: H = High; M = Moderate; L = Low.

Soil type. Desirable soil type. References to soil pH, moisture, and drainage requirements are included if pertinent.

Soil oxygen deficiency resistance. Tree's ability to develop adequately under environmental conditions which reduce root zone soil oxygen, such as extreme soil compaction, seasonal high water tables, fill, pavement, etc.

Salt resistance. Trees' ability to develop adequately given soil or airborne contamination by road salt (NaCl).

Irrigation need. Average amount of irrigation required for normal growth in inches per week. L = less than 1/2"; M = 1/2"-1"; H = greater than 1".

Shade tolerance. Trees' ability to develop adequately in low direct light environments.

Artificial light tolerance. Trees' ability to develop adequately when subjected to prolonged exposure to artificial light.

Air pollution resistance. Trees' ability to develop adequately given high levels of common air pollutants, including ozone (0-3), sulfur dioxide (SO_2), hydrogen fluoride (HF), and nitrogen oxides (NO_x).

Maintenance Characteristics

Tree characteristics affecting maintenance requirements are described.

Insect and disease problems. Common insect or disease problems that are life threatening, disfiguring, or those that consistently require maintenance.

Wood strength. Resistance to storm damage given a good branch and leader structure.

Litter. Foliage, flower, fruit and twig litter that may increase maintenance needs are noted.

Ornamental Characteristics

The Tree Selection Matrix uses the following terms to identify the aesthetic characteristics of mature trees:

Texture. Perception of surface characteristics of the foliage. Texture is primarily a function of leaf size, although leaf arrangement and glossiness of leaf surface are also significant.

Flowers. Flower color, season, and fragrance are noted if important.

Fruit. Fruit color and type are noted if conspicuous.

Bark. Ornamental bark features are described.

Foliage. Unusual foliage characteristics and fall color (F.C.) are noted.

Objectionable features. Self-explanatory.

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
LARGE 40'											
Formal											
Abies concolor White Fir	1-3	pyramidal	70	25	low	dense	med.	shallow, spreading	mod.	long	well drained, light loam, chlorotic in alkaline soils
Acer platanoides Norway Maple	1-3	broad, round	60	45	ave.	dense	med.	shallow, girdling	mod.	mod.	rich, well drained
Acer rubrum Red Maple	1-3	elliptic to round head	60	40	ave.	dense	large	shallow	rapid	short	prefers moist, slightly acid soil-not clay
Fagus sylvatica European Beech	1-3	broad cone horizontal branches	50	30	low	dense	med.	fibrous, some shallow	slow	mod.	light garden soil-not alkaline
Liquidamber styraciflua Sweet Gum	2-3	broadly pyramidal	60	25	ave.	ave.	med.	fibrous	mod.	mod.	chlorotic in strongly alkaline soils
Liriodendron tulipifera Tulip Tree	1-4	erect, oblong	60	30	ave.	ave.	med.	fibrous tender	mod.	long	deep, well drained loam-acid soil
Picea abies Norway Spruce	1-3	conical	80	25	low	dense	med.	fibrous shallow	rapid	mod.	tolerant to most if moist
Picea pungens Colorado Spruce	1-3	broad, dense, regular pyramid	80	30	low	dense	med.	taproot	mod.	long	rich moist, sensitive to changes in irrigation
Picea pungens glauca Colorado Blue Spruce	1-3	broad, dense, regular pyramid	80	30	low	dense	med.	taproot	mod.	long	rich moist, sensitive to changes in irrigation
Pinus nigra Austrian Pine	1-4	broad, spreading, flat top	50	25	low	dense	med.	taproot	mod.	long	very tolerant if well drained
Pinus ponderosa Ponderosa Pine	1-4	upright, columnar to rounded	80	30	ave.	dense	large	taproot	rapid	long	prefers deep well drained loam
Platanus acerifolia London Plane Tree	1-4	broad, spreading crown	60	40	low	ave.	large	fibrous, spreading deep	rapid	long	prefers deep rich soil
Populus nigra 'Italica' Lombardy Poplar	1-4	columnar, ascending	90	15	low	ave.	large	invasive, shallow	rapid	short	very tolerant, endures alkaline soil
Pseudotsuga menziesii Douglas Fir	1-4	open, broad, spiry pyramid	80	20	low	dense	large	taproot	mod.	long	moist, well drained, slightly acid
Tilia cordata Littleleaf Linden	1-4	erect and pyramidal	50	35	low	dense	med.	fibrous, spreading	mod.	mod.	tolerant to most
Thuja occidentalis American Arborvitae	1-3	dense, broad cone	50	20	low	dense	small	taproot	mod.	long	deep, moist, porous loam
Zelkova serrata Japanese Zelkova	2-3	vase shaped	50	40	low	ave.	med.	deep, spreading	mod.	mod.	prefers moist deep soil, pH tolerant

Require.						Maintenance Characteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
	H	M	M		H	mistletoe, heart rot	mod.		fine				silvery green	difficult to establish
H	H	M	L	L	H	aphids, verticillium, summer leaf scorch	mod.	fruit, fol.	med.	yellow-green pendent	Samara-heavy crop	smooth dark grey	f.c.-yellow	difficult to grow grass under
M	M	M	M	M	H	aphids	weak	fruit, fol.	med.	red in spring			f.c.-scarlet	
H	L	M	L		M		strong	fruit, fol.	med.					grass won't grow beneath, drops leaves in winter
M	L	M	L	H	M	scale, iron chlorosis	strong	fruit, fol.	med.		persistent, brown spiny balls		f.c.-scarlet	
	L	M	L		L	aphids, verticillium	mod.	flws., fol.	med.	yellow in summer			f.c.-yellow	
L	M	M	M		M	Spruce Gall Aphid, borers, Tussock moth, scale	mod.	fruit	med.				evergreen	
L	H	M	M		H	Spruce Gall Aphid, Tussock moth, scale	mod.	fruit	coarse				evergreen	
L	H	M	M		H	Spruce Gall Aphid, Tussock moth	mod.	fruit	coarse				blue	
	H	L	L	H	M	wood rots, scale	mod.	fruit	coarse			plated	evergreen	
		L	M	L	M	weevils, aphids, borers, sawfly, wood rot	strong	fruit	coarse			scaly	evergreen	sharp, stiff leaves
H	L	M	M	L	H	moderate Anthracnose resistance, Plant bugs	strong	fruit, fol., bark	coarse		ball-like	peeling, cream color	f.c.-brown	
H	M	M	L		L	cytospora canker, tent caterpillar	weak	fol.	med.					
	M	M	L		M	Spruce Gall Aphid	strong	fruit	med.	purple in spring				
M	M	M	M	M	H	aphid, Leopard moth larvae, summer leaf scorch	strong	fruit, fol., twigs	med.	yellow, fragrant in summer			f.c.-yellow	Honeydew flowers attract honeybees
L	M	M-H	M		H	Red spider mite, bagworm, heart rot	mod.		med.				evergreen	foliage may yellow in cold winter
		M	M			Elm leaf beetle	mod.	fol.	med.		blue berry	mottled	f.c.-reddish	young trees susceptible to frost

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
Semi-Formal											
Acer pseudoplatanus Sycamore Maple	1-3	broad, round	50	30	ave.	dense	med.	shallow	mod.	mod.	rich, well drained
Acer saccharum Sugar Maple	1-3	upright to spreading	60	40	ave.	dense	large	deep, spreading	mod.	long	medium textured fertile soil, slightly acid
Acer saccharinum Silver Maple	1-4	oblong crown, often narrow crotch angles	75	40	low	ave.	large	fibrous, in vasive	rapid	short	rich and moist, not alkaline
Celtis occidentalis Common Hackberry	1-4	oblong	50	40	ave.	ave.	med.	fibrous	mod.	mod.	very tolerant
Fraxinus americana White Ash	1-4	round	60	40	ave.	ave.	med.	deep	rapid mod.	mod.	very tolerant
Fraxinus pennsylvanica Green Ash	1-3	irregular, open head	50	30	ave.	ave.	med.	fibrous	rapid	mod.	moist loam-takes some alkalinity
Ginkgo biloba Ginkgo	1-3	open and ascending	70	40	ave.	ave.	med.	fibrous	slow	long	very tolerant
Gleditsia triacanthos inermis Thornless Honey Locust	1-4	round and spreading	65	50	ave.	open	med.	fibrous, directed down	rapid	mod.	tolerant to most soils
Gymnocladus dioicus Kentucky Coffee Tree	1-4	oval	50	25	low	ave.	med.	deep descending	slow	mod.	prefers rich, deep soil, but tolerant to poor soil
Juglans nigra Black Walnut	1-3	large round head	80	50	high	ave.	large	descending taproot	mod.	long	prefers moist rich soil
Pinus sylvestris Scotch Pine	1-4	wide, spreading flat top	60	25	low	dense	med.	taproot	rapid	long	prefers deep, well drained loam
Populus canadensis Carolina Poplar	1-4	oblong to round	80	50	ave	ave.	med.	fibrous, invasive	rapid	short	moist loam prefered
Populus fremontii Fremont Poplar	4	oblong, erect	60	40	high	ave.	large	invasive, shallow	rapid	short	very tolerant, endures alkaline soils
Populus candicans Balm of Gilead	1-4	broad topped	80	60	ave.	ave.	med.	invasive, shallow	rapid	short	very tolerant, endures alkaline soils
Quercus alba White Oak	1-4	broad, spreading crown	60	40	low	ave.	large	deep taproot	slow	long	well drained, rich soil
Quercus macrocarpa Bur Oak	1-4	broad, round crown	50	30	low	ave.	med.	deep taproot	slow	long	well drained rich soil, prefers acid soil
Quercus robur English Oak	2-4	wide, open head	90	40	low	ave.	large	deep taproot	mod.	long	tolerant to most, prefers acid soil
Quercus rubra Northern Red Oak	1-4	pyramidal, becoming rounded	90	60	low	ave.	large	deep	mod.	long	well drained, rich soil

Require.						Maintenance Characteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
	L	M	L			aphids, verticillium, summer leaf scorch	mod.	fruit, bark	med.				f.c.-yellow-green	difficult to grow grass under
L	L	M	M		M	aphids, verticillium, summer leaf scorch	strong	fol.	med.	red in early spring			f.c.-scarlet	competes poorly with sod
H	H	H	M		H	aphids, iron chlorosis	weak	fol., wood	med.				f.c.-orange-red	narrow crotch angles, brittle wood
M	H	L	M		H	Witchesbroom, Hackberry Nipple Gall Insect	strong	fol.	med.		purple drupe	warty	f.c.-yellow	
H	M	M	M		L	scale borers (lilac)	mod.	fruit, flws.	med.				f.c.-purple	
H	M	M	M		L	scale borers (lilac)	mod.	fruit, fol.	med.				f.c.-yellow	fruitfall
H	M	M	L	M	H	pest free	strong	fruit	med.				f.c.-yellow	plant male only, Fruit on female smells bad
H	H	M	L	M	M	Pod Gall Midge, Thyronectria canker	mod.	fruit	fine				f.c.-yellow	
	L	M	L		M		strong	fruit, fol.	fine				f.c.-yellow	
M	M	M	L		H	aphids	strong	fruit, fol.	med.		large green walnuts		f.c.-brown	
	M	M	L		L	aphids, rust, borers, wood rot, scale	mod.	fruit	med.			scaly, red-brown	evergreen	
H	M	M-H	L		H	cytospora canker	weak	fruit, fol., wood	med.				f.c.-yellow	invasive roots, weak wood
H	M	M	L		L	tent caterpillar, cytospora canker	weak	fruit, fol., twigs	coarse		cottony achenes		f.c.-yellow	use cottonless varieties, invasive roots
H	M	M	L		L	cytospora canker	weak	fruit, fol., twigs	coarse				f.c.-yellow	invasive roots, weak wood
M	M	L	L		M	scale, gall, anthracnose	strong	fruit, fol.	coarse		acorns		f.c.-brown	late leaf fall
M	M	M	M		M	borers, galls, leaf spot	strong	fruit, fol.	coarse		acorns		f.c.-brown	leaves fall into winter
L	H	M	M		M	powdery mildew, galls	strong	fruit, fol.	coarse		acorns		f.c.-brown	leaves fall into winter
L	M	L	L		M	borers, anthracnose, leaf wilt, galls	strong	fruit, fol.	coarse		acorns		f.c.-red	late leaf fall

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
Semi-Formal (continued)											
Robinia pseudoacacia Black Locust	1-4	oblong with rounded top	50	30	ave.	open	med.	shallow spreading	rapid	short	very tolerant
Salix matsudana 'Navajo' Globe Navajo Willow	1-4	spreading, round top	70	60	ave.	ave.	large	invasive	rapid	short	tolerant, except for rocky or dry soils
Tilia americana American Linden	1-4	tall, stately, round topped	80	50	high	ave.	med.	deep	mod.	mod.	deep, well drained, rich soil
Informal											
Acer negundo Box Elder	1-4	round to irregular crown	50	40	low	ave.	large	fibrous, invasive	rapid	short	very tolerant
Ailanthus altissima Tree of Heaven	1-4	round top	60	40	ave.	ave.	large	fibrous	rapid	short	very tolerant
Catalpa speciosa Western Catalpa	1-4	oblong to irregular crown	70	40	high	ave.	med.	fibrous	rapid	short	quite tolerant to most soils
Populus alba White Poplar	1-4	irregular, spreading	80	50	low	ave.	large	fibrous invasive	rapid	short	moist loam preferred
Ulmus pumila Siberian Elm	1-4	round open head	60	45	high	open	med.	fibrous, shallow	rapid	short	very tolerant

Require.						Maintenance Characteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
L	H	L	L		H	Locust borers, leaf miners	weak	fruit, fol.	med.	white fragrant in early sum.			f.c.-yellow	borers serious problem, weak wood
H	M	M	L		L	wetwood or slime flux, aphids, scale carpenter worm	weak	twigs	fine	yellow in early spring				high maintenance, in vasive roots
	M	M	M		M	aphids, summer leaf scorch	strong	fruit, fol., twigs	med.	yellow, fragrant in summer			f.c.-yellow	honeydew flux, attracts honeybees
M	M	L	M		M	box elder bugs, aphids verticillium	weak	fruit, twigs	med.				f.c.-yellow	weak wood, suckering, insects
H	H	L	M		M		weak	fruit, flws., wood	med.					male flowers smell bad, reseeds, suckers
	M	L	L	L	M	Sphinx moth larvae, verticillium	mod.	fruit, flws., fol.	coarse	yellow-green	red sumara in summer		f.c.-brown	messy
H	M	M-H	L		H	cytospora canker	weak	fruit, fol.	med.	white in summer	long, narrow pods		white underneath f.c.-yellow	wounds don't heal well, invasive roots
M		L	L	M		Elm leaf miner, Tussock moth, Elm leaf beetle	weak	fruit, fol., twigs	fine					very messy

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
MEDIUM 25'—40'											
Formal											
Acer campestre Hedge Maple	1-3	broad, elliptic crown	30	20	low	dense	med.	fibrous	slow	mod.	tolerates poor soil or sand
Aesculus carnea Red Horsechestnut	1-3	oblong crown	40	30	low	dense	med.	fibrous	mod.	mod.	loam prefered, but tolerant to most
Aesculus hippocastanum Horsechestnut	1-3	erect branching, oblong crown	40	40	low	dense	med.	fibrous, descending	mod.	mod.	loam prefered, but tolerant to most
Crataegus lavellei Carriere Hawthorn	1-4	oblong	25	10	low	dense	small	deep	mod.	mod.	well drained pH 6.5-7.5
Pinus halepensis Aleppo Pine	4	pyramidal becoming open	40	30	low		med.	tap root	rapid	long	very tolerant if well drained
Robinia ambigua 'Idahoensis' Idaho Flowering Locust	1-4	round canopy	40	20	low	open	med.	aggressive, fibrous	mod.	mod.	tolerant
Sorbus aucuparia European Mountain Ash	1-4	erect, ovate crown	30	20	low	ave.	med.	fibrous, spreading	mod.	short	tolerant, except to very alkaline soils
Semi-Formal											
Betula pendula European White Birch	1-4	pyramidal/oblong, pendulous branches	40	20	low	open	med.	deep spreading	rapid	short	deep moist loam
Crataegus laevigata English Hawthorn	1-4	round, with arching branches	20	15	low	ave.	small	deep	rapid	mod.	well drained pH 6.5-7.5
Crataegus phaenopyrum Washington Hawthorn	1-4	round spreading	25	20	low	open	small	deep	rapid	mod.	tolerant to most soils
Fraxinus holotricha 'Moraine' Moraine Ash	4	round headed	35	25	low	ave.	med.	fibrous	rapid	mod.	well drained soils
Fraxinus velutina 'Modesto' Modesto Velvet Ash	4	irregular to rounded crown	40	30	low	ave.	med.	fibrous	rapid	mod.	well drained; Chlorotic in heavily alkaline soils
Melia azederach Chinaberry	4	spreading round top	40	30	low	dense	med.	fibrous	rapid	mod.	tolerant, tolerates alkaline soils
Morus alba 'Kingan' Kingan Mulberry	1-3	broad, open crown	40	25	low	ave.	large	shallow, fibrous	mod.-rapid	mod.	very tolerant
Pinus flexilis Limber Pine	1-4	broadly pyramidal	40	30	low	dense	med.	tap root	slow	long	tolerant, prefers coarse & well drained
Salix babylonica Weeping Willow	1-4	round head, pendulous branches	40	30	low	dense	large	spreading, invasive	rapid	short	tolerant, except for rocky or dry soils

Require.						Maintenance Characteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
M	M	M	M		H	aphids, veticillium	strong	fruit, fol.	med.				f.c.-yellow	stem suckering
		M	L		H	summer leaf scorch	mod.	fruit, flws., fol.	coarse	spikelike red clusters	nuts			mildly poisonous
	H	M	L		H	summer leaf scorch	mod.	fruit, flws,. fol.	coarse	spikelike white clusters	large nuts			mildly poionous
M		M	M			fireblight, aphids	mod.	fruit, fol.	med.	white in Spring	red pome		f.c.-red	thorns
		L	L			mites	strong	fruit	med.		cone		evergreen	
L	H	L	L		L	locust borer	weak	fruit, wood	fine	purple in early summer	pods		f.c.-yellow	brittle wood, roots sucker, reseeds
L	H	M	L		M	fireblight, scale, borers, cytospora canker	mod.	fruit, fol.	fine	white in early summer	clusters of red berries	orange hue	f.c.-yellow-orange	sunscald, fruit drop
	M	M	L	L	M	Bronze Birch Borer, cytospora canker	weak	twigs	fine		catkins	white, peeling	f.c.-yellow	
		M	L			fireblight, aphids	mod.	fruit, fol.	med.	white in spring	red pome			thorns
H	H	M	L		H	fireblight, aphids	mod.	fruit, fol.	med.	white in spring	red pome		f.c.-red	thorns
		M	M			verticillium	mod.	fruit, fol.	med.				f.c.-yellow	litter
		M	M			heart rot may infest pruned trees	mod.	fruit	med.				f.c.-yellow	
		M	M			heart rot, Texas root rot	weak	fruit, flws., fol.	fine	purple in spring	yellow berries		f.c.-yellow	poisenous fruit suckers
H	H	L	M			mites, bacterial blight	mod.	fol., twigs	med.					
		L	L		H	wood rots, borers, weavil, sawfly	strong	fruit	med.				evergreen	
H	M	M-H	L		L	cytospora canker, scale aphids, carpenter worm	weak	twigs	fine	yellow in early spring				high maintenance, invasive roots

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
Semi-Formal (continued)											
Sophora japonica Japanese Pagoda Tree	1-4	broad, oval crown	40	40	low	ave.	med.	fibrous shallow	mod.	mod.	tolerant except for heavy clay-prefers slightly acid soil
Syringa verticulata Japanese Tree Lilac	1-3	broad round crown, multi-trunked	30	20	low	dense	small	fibrous	mod.	mod.	prefers moist garden loam
Ulmus parvifolia Chinese Elm	2-4	vase-shaped	40	25	ave.	ave.	med.	shallow, fibrous	mod.	mod.	tolerant
Informal											
Betula occidentalis Western Water Birch	1-4	ascending limbs in clumps	35	15	low	open	med.	deep, spreading	rapid	short	deep, moist loam
Zizyphus jujuba Chinese Date	4	irregular form, pendulous branches	30	20	low	ave.	small	deep	mod.	mod.	tolerant, takes alkaline soils

Require.						Maintenance Characteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
H	H	M	L	M	H	leafhoppers	weak	fruit, fol.	fine	yellow in late summer	segmented pods	green twigs	f.c.-yellow	
	M	M	L		M	powdery mildew, lilac borer	strong	flws., fol.	med.	white in late spring		cherry-like		
		M	L		M	resistant to Dutch Elm Disease, Elm Leaf Beetle	weak	fol., twigs	fine			mottled	f.c.-red-orange	brittle wood
		M-H	L			fewer problems than *Betula pendula*	weak	fol., twigs	fine		catkins	cinnamon, peeling	f.c.-yellow	suckers
		L	M			Texas root rot	mod.	fruit, fol.	fine		brown "dates"		f.c.-yellow	basal suckers thorns

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
SMALL — 25'											
Formal											
Acer platanoides 'Globosum' Globe Norway Maple	1-3	dense, round crown	20	20	low	dense	small	shallow fibrous	mod.	mod.	rich, well drained
Ligustrum lucidum Glossy Privet	4	dense, formal, round head	25	20	low	dense	small	fibrous	rapid	mod.	tolerant prefers garden soil with good drainage
Pinus edulis Pinyon Pine	1-4	shrubby, upright and rounded	20	15	low	dense	small	extensive, shallow	slow	long	coarse, will drained, slightly alkaline
Pinus thunbergii Japanese Black Pine	2-4	conical to irregular	20	15	low	dense	small	tap root	mod.	long	prefers deep, well drained loam
Prunus cerasifera 'Newport' Newport Flowering Plum	2-4	oblong, with ascending branches	25	20	low	dense	small	fibrous	rapid	mod.	garden loam
Pyrus calleryana 'Bradford' Bradford Pear	2-3	broadly pyramidal	25	15	low	dense	small	deep spreading	rapid	mod.	tolerant prefer slightly acid to neutral
Semi-Formal											
Acer ginnala Amur Maple	2-3	oval, multi-trunked	20	15	low	dense	small	fibrous	mod.	mod.	tolerant
Albizzia julibrissin Silk Tree	2-4	spreading, flat-topped crown	15	20	low	open	small	fibrous	rapid	short	tolerant but prefers garden loam
Cercis canadensis Eastern Redbud	2-4	broad, round head	25	20	low	dense	small	fibrous	slow	mod.	light, rich, moist loam
Eriobotrya japonica Loguat	4	umbrella-like crown	25	20	low	dense	small	fibrous	mod.	mod.	tolerant but needs good drainage
Juniperus osteosperma Utah Juniper	1-4	rounded, multi-branched	20	15	low	dense	small	fibrous spreading	slow	long	coarse and rocky
Juniperus scopulorum Rocky Mountain Juniper	1-4	pyramidal to open crown	25	15	low	dense	small	fibrous spreading	slow	long	tolerent, prefers well drained
Koelreuteria paniculata Golden Rain Tree	2-3	dense, round head	25	25	low	ave.	small	fibrous	mod.	short	
Laburnum watereri Golden Chain Tree	2-3	upright to round head	15	10	low	open	small	fibrous	mod.	mod.	moist, well drained takes alkaline soils
Lagerstroemia indica Crape Myrtle	4	vase shaped often multi-stemmed	20	15	low	ave.	small	fibrous	mod.	mod.	deep soil with good drainage
Malus 'Dolgo' Dolgo Crabapple	1-4	rounded, open	30	30	low	ave.	small	fibrous	mod.	short	perfers good garden loam
Malus 'Dorothea' Dorothea Crabapple	1-4	rounded, dense branching	20	15	low	ave.	small	fibrous	mod.	short	perfers good garden loam

Require.						Maintenance Charcteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
H	H	M	L	L	H	aphids, verticillium, summer leaf scorch	mod.	fruit, fol.	med.				f.c.-yellow	difficult to grow grass under
		M	L			root knot nematodes, privet weevil, Texas Root Rot	mod.	fruit	med.	white in late spring	black berries		glossy dark green	fruit poisonous
		L	L			scale	strong	fruit	med.				evergreen	
		M	L				mod.	fruit	coarse				evergreen	
M	M	M	L		M	Leaf spot, Black knot	mod.	fol.	med.	pink in spring	seldom fruits	dark red	purple-red	
M	M	M	L	H	M	occaisional fireblight	strong		med.	white in spring	seldom fruits		f.c.-bronze	
	M	L-M	L		H	aphids, verticillium	strong	fruit, fol.	med.		red samaras in summer		f.c.-red	
		M	M				weak	flws., fol.	fine	pink in summer	papery pod		f.c.-yellow	hard to establish
L	L	M	H		M	cold sensitive	weak	fol.	med.	pink	pod		f.c.-yellow	
		M	L			fireblight, red spider mite	mod.	fruit, flws.	course	white in fall	yellow, pear-like		evergreen	frosts, blight, fruit attracts bees
		L	L				mod.		med.		blue berries	shredding	evergreen	
		L	L		H		mod.		med.		blue berries	shredding	evergreen	
		M	M	M		verticillium	weak	fruit, flws., fol.	med.	yellow in summer	brown capsules			litter
L		M	M			aphids, twig blight	mod.	flws., fol.	fine	yellow in late spring		olive twigs		seeds are poisonous
		M	M			powdery mildew	mod.	flws., fol.	med.	wide color selection		mottled	f.c.-orange	leaf burns in hotwinds
H	H	M	L		M	aphids	mod.	fruit, fol.	med.	white (alt.)	red			blooms in alternate years
H	H	M	L			aphids, susceptible to fireblight	mod.	fruit, fol.	med.	rose pink	yellow			

Tree	H.Z.	Physical Characteristics									Habitat
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type
Semi-Formal cont.											
Malus floribunda Japanese Flowering Crabapple	1-4	low, broad, round crown	25	30	low	ave.	small	fibrous spreading	mod.	short	perfers good garden loam
Malus 'Hopa' Hopa Crabapple	1-4	low, broad, round crown	25	20	low	ave.	small	fibrous spreading	mod.	short	perfers good garden loam
Malus ioensis 'Plena' Betchel Crabapple	1-4	round headed, open	25	20	low	ave.	small	fibrous spreading	mod.	short	perfers good garden loam
Malus 'Radiant' Radiant Crabapple	1-4	compact, upright	25	20	low	ave	small	fibrous spreading	mod.	short	perfers good garden loam
Malus zumi calocarpa Redbud Crabapple	1-4	Pyramidal, dense branching	20	10	low	ave.	small	fibrous spreading	mod.	short	perfers good garden loam
Nerium oleander Oleander	4	broad crown, often multi-stemmed	20	15	low	ave.	small	fibrous	rapid	mod.	widely tolerant
Prunus padus 'Commutata' May Day Tree	1-4	open, upright	20	15	low	ave.	small	fibrous	mod.	mod.	
Informal											
Acer glabrum Rocky Mountain Maple	1-4	round, multi-trunked	25	15		dense	small	shallow	mod.	mod.	well drained
Amelanchier alnifolia Saskatoon Serviceberry	1-4	upright, bushy	20	15		ave.	small	fibrous	slow	mod.	deep, well drained, pH 6.0-7.0
Elaeagnus angustifolia Russian Olive	1-4	irregular, open head	20	20		ave.	med.	fibrous	rapid	mod.	very tolerant takes alkaline & gravely soils
Quercus gambelii Gambel Oak	1-4	shubby, with irregular crown	25	15		ave.	small	deep	slow	long	coarse, well drained, slightly alkaline

Require.						Maintenance Charcteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features
H	H	M	L			aphids, slightly susceptible to fireblight and powdery mildew	mod.	fruit, fol.	med.	pink to white	yellow or red			
H	H	M	L			Highly susceptible to fireblight, powdery mildew, aphids	mod.	fruit, fol.	med.	red-pink	orange-red			
H	H	M	L			aphids, fireblight	mod.	fol.	med.	pink	few fruit			
H	H	M	L			aphids, resistant to fireblight	mod.	fruit, fol.	med.	pink	red		reddish cast	
H	H	M	L			aphids, fireblight	mod.	fruit, fol.	med.	white (alt.)	red			blooms in alternate years
		M	L			aphids, scale, Texas root rot	mod.	flws.	med.	wide color selection			evergreen	all parts poisonous, must train into tree
H	M	M	L		M	tent caterpillar	mod.	fruit, fol.	med.	white in spring	black	dark red	purple-red	
		M	M			aphids, verticillium	strong	fruit, fol.	med.				f.c.-orange	stem suckering
		M	M			cedar serviceberry rust	mod.	fruit, fol.	med.	white, fragrant	blue-black	gray, smooth	red-purple	suckers, train to tree
	H	L	L			fireblight, aphids	mod.	fruit, fol., twigs, bark	med.	yellow, fragrant			silver-gray	reseeds, spines
		L	L			root rot if over-watered, gall	strong	fruit, fol.	course		acorns			late leaf fall, creeping root system

Tree	H.Z.	Physical Characteristics										Habitat	
Botanical name Common name	1-4	Form	Height (in feet)	Spread (in feet)	Height to Canopy Bottom	Canopy Density	Trunk Size	Root Habit	Rate of Growth	Longevity	Soil Type	Native Species

Require.						Maintenance Characteristics			Ornamental Characteristics					
Soil Oxygen Def. Resistance	Salt Resistance	Irrigation Need	Shade Tolerance	Artificial Light Tolerance	Air Pollution Resistance	Insect and Disease Problems	Wood Strength	Litter	Tree Texture	Flowers	Fruit	Bark	Foliage	Objectionable Features

Additional Trees

The list of species included in the matrix is not exhaustive, but rather a list of generally recommended species. New tree species, hybrids, and cultivars have been developed since publication of the first edition of the Community Forestry Manual. Listed hereafter are additional recommended cultivars. Keep in mind that testing of new cultivars and hybrids is an ongoing process. Many of the new introductions may possess qualities that are superior to those included in the matrix. Check periodically with the state horticulturist, forester, or arboretum director for information on new introductions.

Large Formal

Acer platanoides 'Cleveland'	Cleveland Norway Maple
Acer platanoides 'Columnare'	Columar Norway Maple
Acer platanoides 'Crimson King'	Crimson King Norway Maple
Acer platanoides 'Parkway'	Parkway Norway Maple
Acer rubrum 'Northwood'	Northwood Maple
Acer rubrum 'Red Sunset'	Red Sunset Maple
Carpinus betulus 'Pyramidal'	Pyramidal European Hornbean
Picea pungens 'Iseli Fastigiata'	Fastigate Blue Spruce
Picea pungens 'Montgomery'	Montgomery Spruce
Platanus acerfolia 'Bloodgood'	Bloodgood London Planetree
Tillia cordata 'Greenspire'	Greenspire Linden
Zelkova serrata 'Village Green'	Village Green Zelkova

Large Semi-Formal

Acer pseudoplatanus 'Erythrocarpum'	Erythrocarpum Sycamore Maple
Acer saccharinum 'Improved'	Improved Silver Maple
Acer saccharum 'Green Mountain'	Green Mountain Sugar Maple
Acer saccharum 'New Sentry'	New Sentry Sugar Maple
Acer saccharnum 'Blair'	Blair Sugar Maple
Celtis occidentalis 'Prairie Pride'	Prairie Pride Hackberry
Fraxinus pennsylvanica 'Marshall Seedless'	Marshall Seedless Green Ash
Fraxinus pennsylvanica 'Patmore'	Patmore Green Ash
Fraxinus americana 'Autumn Purple'	Autumn Purple Ash
Fraxinus americana 'Rosehill'	Rosehill White Ash
Gleditsia triacanthos inermis 'Moranine'	Moranine Honey Locust
Gleditsia triacanthos inermis 'Shade Master'	Shade Master Honey Locust
Tilia americana 'Redmond'	Redmond American Linden
Ulmus americana 'Pioneer'	Pioneer American Elm
Ulmus americana 'Homestead'	Homestead American Elm

Large Informal

Populus alba 'Pyramidalis'	Bolleana Popular

Medium Formal

Acer campestre 'Queen Elizabeth'	Queen Elizabeth Hedge Maple
Aesculus carnea 'Briotu'	Briotu Horse Chestnut
Pyrus calleryana 'Redspire'	Redspire Pear
Sorbus aucuparia 'Asplenifolia'	Asplenifolia Mountain Ash
Sorbus aucuparia 'Beissneri'	Beissneri Mountain Ash
Sorbus aucuparia 'Xanthocarpa'	Xanthocarpa Mountain Ash

Medium Semi-Formal

Betula pendula 'Dalecarlica'	Cutleaf Weeping Birch
Gleditsea triacanthos inermis 'Imperial'	Imperial Honeylocust
Morus alba 'Tartarica'	Russian Mulberry
Morus alba 'Fruitless'	Fruitless Mulberry
Morus alba 'Fan-San'	Fan-San Mulberry
Sorbus aucuparia 'Pendula'	Weeping Mountain Ash

Small Formal

Prunus cerasifera 'Hollywood'	Hollywood Flowering Plum
Prunus cerasifera 'Thundercloud'	Thundercloud Plum
Pyrus calleryana 'Chanticleer'	Chanticleer Pear

Small Semi-Formal

Cercis candensis 'Wither's Pink Charm'	Wither's Redbud
Cercis occidentalis	Western Redbud
Laburnum watereri 'Vossi'	Vossi Goldenchain Tree
Malus ioensis 'Klehm's Improved'	Improved Bechtel Crab
Malus sp. 'Spring Snow'	Spring Snow Crab
Prunus serrulata 'Kwansan'	Kwansan Flowering Crab

Planting Plan and Schedule

Once tree selections have been made, it is necessary to prepare a planting plan. **The purpose of the planting plan is to show the exact location of each plant on the project site.** The planting plan is drawn on a base map of the project site. This is usually a clean copy of the same map used for the project site evaluations. Typically an "X" is used to show where the plant is to be planted and a circle is drawn to show the anticipated spread of the tree. The plant's scientific name or identifying symbol, as well as the number of plants used and their distances apart, on center, are included on the planting plan. A typical planting plan is depicted in Figure 9-3.

The **plant schedule** accompanying the planting plan **includes specific information** on the trees, shrubs, ground covers and other plants to be used. The plant schedule generally includes the following:

Symbol. Used to identify the plant on the planting plan.

Number. Entire number of each species used.

Scientific name.

Common Name.

Size. The specified ranges of plant height, spread and caliper for each species at time of purchase.

Spacing. The desired spacing of the plants.

Conditions. How the plant should be delivered: balled and burlapped (B and B), bare root (BR), or container grown (CG).

Remarks. Specifies any unique attributes each plant should possess, or it may contain specific planting instructions.

Figure 9-4 illustrates how these elements of a plant schedule are arranged.

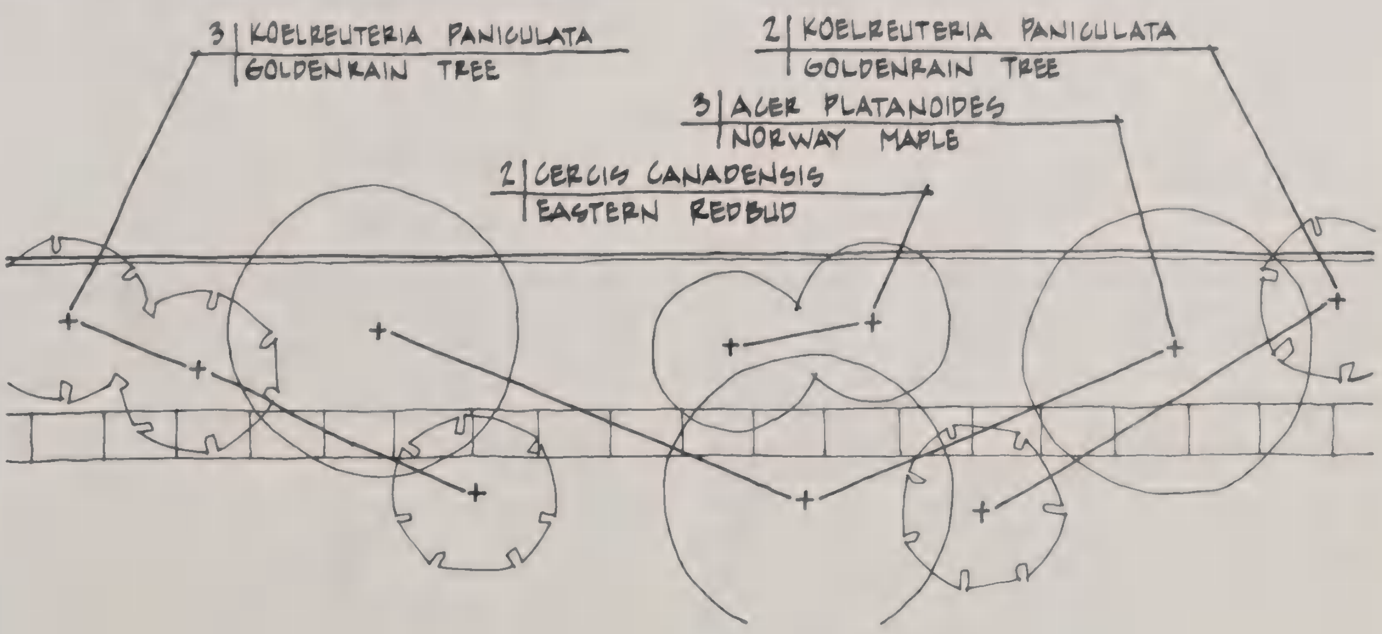


Figure 9-3. A Typical Planting Plan

PLANTING SCHEDULE						
QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACE	COND.	REMARKS
25	ACER PLATANOIDES	NORWAY MAPLE	2-2½"		B&B	
10	CERCIS CANADENSIS	EASTERN REDBUD	1½-2"		B&B	
32	KOELREUTERIA PANICULATA	GOLDENRAIN TREE	1½-2"		B&B	
6	LIQUIDAMBER STYRACIFLUA	SWEETGUM	2-2½"		B&B	
40	COTONEASTER ACUTIFOLIA	PEKING COTONEASTER	5 GAL	5' O.C.	CAN	
24	COTONEASTER APICULATA	CRANBERRY COTONEASTER	3 GAL	3' O.C.	CAN	
24	MAHONIA AQUIFOLIUM	OREGON GRAPE	3 GAL	3' O.C.	CAN	
190	HEDERA HELIX BALTICA	BALTIC IVY		6" O.C.	FLAT	
240	VINCA MINOR	PERIWINKLE		6" O.C.	FLAT	

Figure 9-4. An Example of a Planting Schedule

Planting Specifications

After the planting plan and schedule have been developed for a specific project, it may be necessary to write a set of planting specifications. If the city elects to bid the planting and construction work out to a landscape contractor or if the design firm the city has contracted is managing the entire project, planting specifications should be written in detail. If non-professionals will be planting the vegetation, more general specifications can be used to help instruct them in planting techniques prior to planting.

Planting specifications are documents which spell out in detail all the necessary information concerning selection, placement, installation procedures and maintenance programs (Johnson & Becker, 1976). Specifications legally insure the client that the landscape contractor performs the jobs as specified in the documents. Because planting specifications are legally binding, they must be carefully and clearly written by an experienced individual. The specifications generally consist of three parts: a general part which describes the project's scope, a discussion of products which will be used, and specifications for execution.

Staking Plan

After completing the planting plan, schedule and specifications locate each proposed tree on the project site. This is most easily done by taking scale measurements from the planting plan. Read the plan scale measurement and lay out the actual measurement on the project site using a tape measure as shown in Figure 9-5.

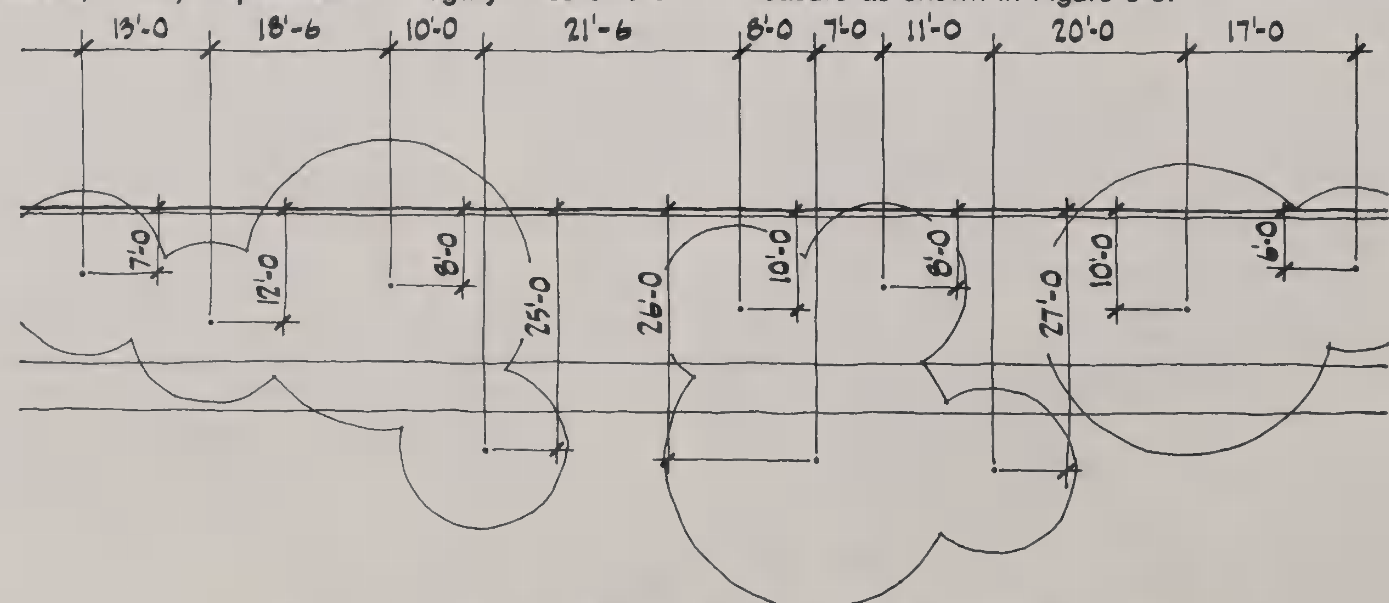


Figure 9-5. A Staking Plan As it Would Be Laid Out in the Field

Drive a stake with the plant name written on it into the soil at each proposed tree location. Each stake identifies the center of a planting pit which will be excavated to plant the tree.

Ordering Plants

Many small communities do not have a municipal nursery and cannot afford to hire private firms to order and plant public trees. The most cost-efficient option for these communities is to order the plants and then allow the citizens to pick them up (at the town square, for example) and plant them in the locations specified on the planting plan. Arbor Day plantings done in this manner generate a spirit of community involvement.

Before ordering trees, examine the catalogs of a number of local nurseries and garden centers. Use the planting schedule to determine how many of each species are needed. Compare the costs for the plants at each outlet. Generally, wholesale nurseries will be least expensive and provide discounts for large orders, but many retail nurseries will also give discounts for a municipally sponsored order, regardless of quantity.

The stock of local nurseries may be better adapted to the local climate and growing conditions than that of nurseries from the Pacific Coast or Midwest. Also, the local nursery stock does not have to be transported long distances or stored until planting time. Local purchases save transportation costs and eliminate your responsibility for any damage which may occur in transit or during extended storage prior to planting. Thus, these advantages of local purchases may justify some higher cost.

It is wise to consult with someone familiar with the local nurseries – such as a landscape contractor, urban forester or landscape architect to determine the relative quality of local nursery stock. Telephone the nurseries to find out whether the stock you desire is available and whether the cost is the same as indicated in their catalog, and if they offer a discount. Also, check to see if they can deliver the stock to a central place in the city from which it can be picked up by the citizens.

After narrowing down the list of nurseries to two or three, it is advisable to visit each, accompanied by someone who is knowledgeable about trees. Examine the condition, size and health of the plants you wish to order (Figure 9-6).

Figure 9-6. Inspecting Nursery Stock is Important in Obtaining Quality Trees

Decide which outlet can provide the best quality stock at the lowest price. If specimen trees are desired, tag them in the nursery during the visit and hold them with a deposit. The order can then be placed with the nursery. If the nursery stock is to be delivered to the city, do not pay for the stock until it has been inspected to insure that it meets specifications. This helps to insure that the plants you receive are those specified and are in good condition after delivery and unloading. **When ordering plants, give the nursery as much lead time as possible. This increases the likelihood of selected plants being available when needed.** Purchase trees as early in the spring as possible. The best trees are shipped first from production nurseries and later orders filled with what's left. The best plants are chosen first at the retail nursery as well. If the plants needed for a specific project are known two or three years before installation is intended, a nursery can be contracted to grow and deliver them. This eliminates the labor and frustration of having to round up plants at the last minute from several nurseries.

On-Site Plant Inspection

Before planting begins, carefully inspect each individual plant. Plants can be damaged when they are removed from the nursery, transported to the site, loaded and unloaded, and while they are on the site prior to planting. Since trees can represent a sizeable investment, it is wise to insure that what goes into the ground is what was paid for at the time of delivery. **Any plants differing in size, age, species, or condition from what was ordered should not be accepted and should be sent back to the nursery and refund or replacement arrangements made.** Reputable nurseries will not resent or dispute such careful evaluation of their delivered products, especially if the order contained detailed, written plant specifications. Appendix M, American Standard for Nursery Stock 1986, contains specifications that apply to shade, flowering and evergreen trees generally sold to the retail and landscape trade. Following is a checklist of things to look for during the on-site inspection.

Size. The plants should have the dimensions of those specified (see Appendix M). Large plants cut back to the specified sizes should not be accepted.

Form. The plants should be typical of their species or variety. Numerous broken branches are a sign of mishandling and can permanently affect plant form. The crown should be well-formed, without excessive pruning.

Vigor. The plants should have well-developed branches and the leaves should be a normal healthy color. Since plants are often delivered dormant and without leaves, look for the numbers and locations of viable buds. Buds, bark, and branches should not be shriveled, desiccated, or discolored.

Roots. Plants balled in burlap should meet minimum specified sizes for the tree and soil ball. A solid ball of earth should be securely held together by burlap and stout twine or a tight wire basket. If the ball is broken or loose, the roots have probably been damaged. If trees in containers lean in one direction or have trunks that can be easily moved, their roots may be damaged. It is also advisable to remove the top portion of burlap around the ball to inspect for kinked, girdled or "J" roots. Circling roots indicate that the roots were not trimmed or were bent and kinked as the plant grew or when it was transplanted from the nursery liner into a container. "Death, ground-level breaking of trunks and poor growth of trees in the landscape can result from roots that are circled or kinked at the trunk near the soil surface" (Harris, Davis, Stice, Long, 1972, p. 1). Container-grown stock may have a tangled and constricted root system. Signs of a rootbound condition are: roots protruding above the soil surface and through the container's drain holes; plants unusually large for the size of their container; unusually leggy plants; dead twigs or branches. Poorly developed roots produce trees subject to stress, wind throw, and weak growth. Many nurseries sell a second grade or "park" grade of trees. These trees have minor bark damage and are less expensive than un-damaged trees. Avoid the temptation to buy second grade stock. The roots of bare-root trees should arrive wrapped in moist burlap and packing. They should be fresh, damp and flexible.

Trunk wounds. The trunk should be free from disfiguring knots, abrasions of the bark, sunscald injury or other defects. The bark should be pliable and green when scraped with a fingernail.

Insects and disease. The plant should not have any insects or insect eggs on it, no borers or woodrot fungi in it. It should also be disease free.

Planting Inspection. Periodic inspections during the planting phase help guarantee that the correct planting procedures are followed. Check to be sure that:

1. The planting hole is as large as specified and will drain. Fill the planting holes with water before planting. If the water does not drain out within 12 to 24 hours, find out why. Break-up hard pans and impermeable layers and/or install drains.

2. The plant is placed in the hole carefully and is not planted too deep or too shallow.

3. The correct backfill material is used, usually the native soil.

4. The plant is watered immediately following transplanting.

5. The plant is protected from injury due to on-site construction activity.

6. The roots are not dried out prior to planting.

Most contractors give guarantee periods. A city can specify and demand a guarantee period from a contractor. Conduct final inspection at the conclusion of this period to determine whether the job is acceptable. The contractor is responsible for replacing dead or unhealthy plants and for taking care of other problems related to his contractual obligations. This protects the client from tree loss due to the planting of unhealthy nursery stock, improper planting, poor follow-up management, or failure of the plant to establish itself.

I think that I shall never see
A poem lovely as a tree

A tree whose hungry mouth is pressed
Against the earth's sweet flowing breast;

A tree that looks at God all day
And lifts her leafy arms to pray;

A tree that may in summer wear
A nest of robins in her hair;

Upon whose bosom snow has lain;
Who inimately lives with rain.

Poems are made by fools like me,
But only God can make a tree.

--*Joyce Kilmer*

Planting Season

Most municipal arborists prefer to plant deciduous trees, either balled in burlap or container grown, in the spring well before bud break. This allows the transplant an entire growing season to develop new feeder roots and establish itself. Deciduous trees can be successfully planted in the fall because their roots are capable of growing even when the soil temperature drops as low as 45 degrees fahrenheit (Pirone, 1978). However, a dry fall followed by a cold winter can be fatal to fall transplants. Trees can be successfully transplanted in the winter if the proper steps are taken prior to transplanting. The tree to be moved has to be heavily mulched so that the surrounding soil is not completely frozen. In addition, the hole receiving the transplant should be dug and mulched in the fall. Trees bought bare-root should be planted in winter or early spring, when they are dormant. They can be purchased at 40 to 70 percent of the price of the same plant later in the year in a container. Transplanting bare-root stock during the summer is not successful because water loss by leaves exceeds the water absorbed by the developing root system. This may cause severe transplant shock that can significantly prolong the establishment period or, worse yet, kill the tree. Balled and burlapped and container grown stock can be successfully transplanted during the summer if proper care is taken.

Pirone (1978) notes that evergreen trees are best transplanted earlier in the fall and later in the spring than deciduous trees. "Greatest success in transplanting evergreens is attained when the soil is warm and root growth continues immediately. Such conditions prevail in most parts of the country in early fall and late spring" (Pirone, 1978, p. 32).

Planting Techniques

Balled and Burlapped Trees

Prior to planting, balled and burlapped (B and B) stock should be placed in a protected area and the ball kept moist with a covering of damp peat moss, sawdust or straw. When handling the stock, never pick a tree up by the stems or trunk. This will damage the trunk and may separate the soil ball. Do not drop B and B plants since this will crack the soil ball and damage the fragile feeder roots. Cradle the root ball by supporting the bottom with one or both hands or if large, slip it on a canvas or piece of plywood. If the plant is too heavy for one person, use two people to move it.

After moving the tree to a position adjacent to the planting site, dig a planting hole about twice as wide as the root ball and at the same height as the ball. Keep the soil available for backfill. If sod is carefully removed, it can be profitably used elsewhere in the landscape. Do not return grass to the planting hole.

If you encounter a hardpan layer when digging the hole, take special measures before planting to minimize root system constraints by poor soil drainage and inadequate aeration. Dig a deeper and wider hole, using a backhoe if necessary. Mix the extracted soil uniformly with amendments if desired (see below) and return it to the hole. Watering will settle the soil. This work should be done at least several months before digging the planting hole to allow the soil to settle. While this procedure may seem excessive and expensive, it is essential if the tree is to grow. A $1 tree in $10 hole is better than a $10 tree in a $1 hole.

Soil amendments such as peat moss, ground bark and composted manures are commonly incorporated into the native soil and then used as back fill. One shovelful of organic amendment thoroughly mixed with three of soil will improve the fertility and water retention qualities of the backfill soil. However, studies by Carl Whitcomb suggest that backfill soil amendments restrict lateral root development of trees and reduce their anchorage (Hamilton, 1979). Tests showed that the root system in amended soil treatments was confined to the amended soil, whereas when no soil amendments were used the roots extended far beyond the original planting hole and had a larger volume of soil to draw on for water and nutrients. In addition, after a few weeks the amended soils were drier than those without amendments due, in part, to the higher evaporation rate of amended

soils at the soil surface. "If soil amendments are to be used, they should be blended into the entire soil volume used by the young plant and 'feathered out' at the edges. . .The bottom line—a friable soil, native to the site, is a preferred backfill material" (Hamilton, Feb. 1980, p. 2).

Figure 9-7. Make Planting a Tree a Family Adventure

Plant trees so that the original soil level, as indicated by the soil line on the trunk, corresponds with the finished grade. If the bottom of the hole was disturbed upon digging, allow for settling by planting the tree one or two inches higher than grade. Plants set higher than one or two inches above grade will suffer root exposure and root death for the first few inches of roots. Those set lower than grade will experience water-logged conditions, which leads to collar and root rot and subsequent death of the tree. In sandy well-drained sites, plants may be planted 1 to 2 inches lower than grade without danger of root rot. The bottom of the planting hole should be flat undisturbed or compacted earth. Avoid damaging the soil ball. Carefully cut away all of the burlap and remove the wire basket and any rope or plastic twine from around the trunk and roots. All manmade materials must be removed from the root ball. Burlap has often been left, as it is supposed to deteriorate. Recently, however, many tree failures have been attributed to containers which restrict root systems, including burlap as well as twine, plastics, and wire baskets. Once the tree is in place, the container components are no longer needed and thus should be removed. Be sure that the plant is set upright and facing in the desired direction.

Work the backfill around the root ball. Compact it with the end of the shovel handle or your hands. Soak it with water. Fill the planting hole and then water thoroughly. After the soil has settled, add more backfill, and grade the area. The planting method just described is shown in Figure 9-8.

Research results suggest that height growth and trunk diameter increase significantly if the ground near the tree base is kept free of grass. "Besides the clear advantage of preventing turf competition to young trees, expect fewer tree injuries caused by mowing equipment. . . ." (Hamilton, March 1980, p. 2). Mulch the soil surface with two or three inches of a coarse slow-decomposing media such as shredded bark, wood chips, peat or compost. Organic mulches retain moisture, retard evaporation, moderate soil temperatures, control weeds and improve appearance. Uncomposted manure and mulches such as grass clippings and sawdust, decompose rapidly and require additional applications of nitrogen because the decomposing bacteria in the mulch compete vigorously with the tree for available nitrogen. Therefore, these types of mulches should not be used. Mulches should not be placed directly against the tree trunk. They may harbor insects and mice which may girdle or otherwise damage the tree.

Prune broken and diseased branches. It has been assumed that pruning some branches in the top will compensate for root loss resulting from the digging operation. However, a new school of thought is emerging. Research suggests that pruning after transplanting may actually harm the tree. Leaves manufacture food and the terminal buds of branches produce auxins (growth hormones) both of which stimulate root growth. Since root growth is critical to establishing the tree; pruning may not be beneficial. Further, pruning creates wounds upon which the tree must expend energy to seal. Branches also function as organs for storing carbohydrates (food) used for root and top growth. Removing the branch removes not only the storage location, but also the food stored there. If pruning is necessary to reduce

transpirational area to compensate for root loss, the root-to-shoot ratio is extremely unbalanced. Consider rejecting such a tree. The only pruning that should be done prior to establishment is to remove broken and diseased branches. The less a young tree is pruned the sooner it will become established. Leave small shoots along the trunk. They stimulate trunk diameter growth and protect the trunk from sunscald when in leaf, particularly if on the south or west side of the tree. They also provide a visual and physical barrier that may reduce tree vandalism. "A tree with unpruned or lightly headed shoots along the trunk (10" to 12") shows these features when compared with one having few, severely headed (4" to 6"), or no shoots along the trunk:

*greater caliper at trunk base

*less height growth

*more trunk taper" (Harris, Leiser, Davis, 1969, p. 2).

For additional information on pruning young trees, see Chapter XII.

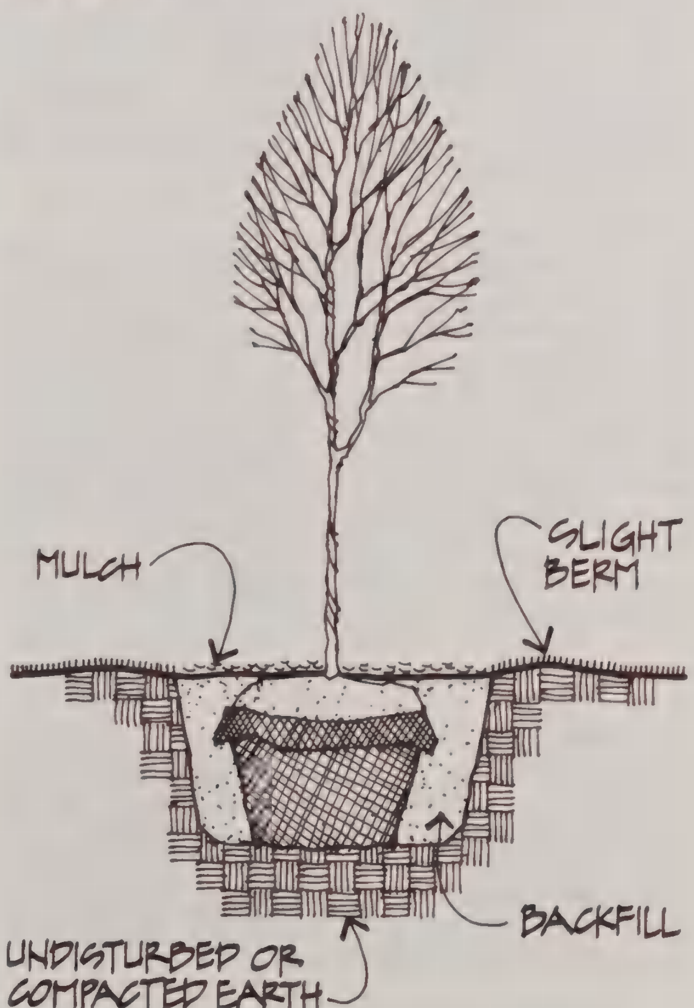


Figure 9-8. Planting a Balled and Burlapped Tree Remove Wrapping Before Backfilling Hole

Container Grown Trees

Most trees come from nurseries in containers; however, evergreens are commonly balled in burlap. Container grown trees (CG) have developed root systems in the contained soil and are "established." The most common containers are 5, 7, and 15 gallon metal or plastic containers. Large trees come in wooden boxes. If planting is delayed, keep the trees in a partially shaded cool place protected from the wind. Water them enough to keep the roots moist (once daily when they are in leaf). Dig the planting hole at least twice the width of the container and as deep. If a small tree is to be planted (5 gal.), it is easiest to remove the container before placing the plant in the hole. Slit the metal can down the sides with a can cutter. Beware of the cut edges. Handle the uncut portion to avoid injury. If the container is tapered and not fluted, sharply tap the bottom and sides and slide the root ball out. Move the tree into the planting hole carefully to keep the root ball from breaking or falling apart. Wrap the ball securely in burlap or hold it together with your hands if necessary. Before back filling, look at the roots. **If they are crowded or coiled on the bottom, sides, or surface of the root ball, gently tease them away from the edges.** If the roots are pot bound (dense and circling), return the tree to the nursery for a replacement or as a last resort, make several vertical cuts with a knife, then gently loosen the roots at the sides and bottom of the root mass and spread them into the hole. Cutting roots encourages infestation of numerous soil borne diseases. Avoid doing so if possible. Kinked root, "J" root, and one-sided root problems can be observed by looking closely at the top of the root ball. Use a pocket knife to expose the top 1 to 2 inches of soil to examine the roots. Girdling roots and lack of fibrous roots can only be observed after the container or burlap wrapping has been removed. Any of these problems can result in poor tree growth or death. If any of these problems are found during planting do not plant the tree. Return it to the nursery for a replacement.

If a large tree is to be planted or if the root ball does not appear to be consolidated, it is often easiest to lower the plant into the hole while it is still in the container. To remove the container slit it along all four sides, then bend the sides back and cut them off on three sides at the bottom. Gently slide the container out from under the root ball by pulling on the remaining side while someone else cradles and lifts the root ball off the bottom of the container (See Figure 9-9).

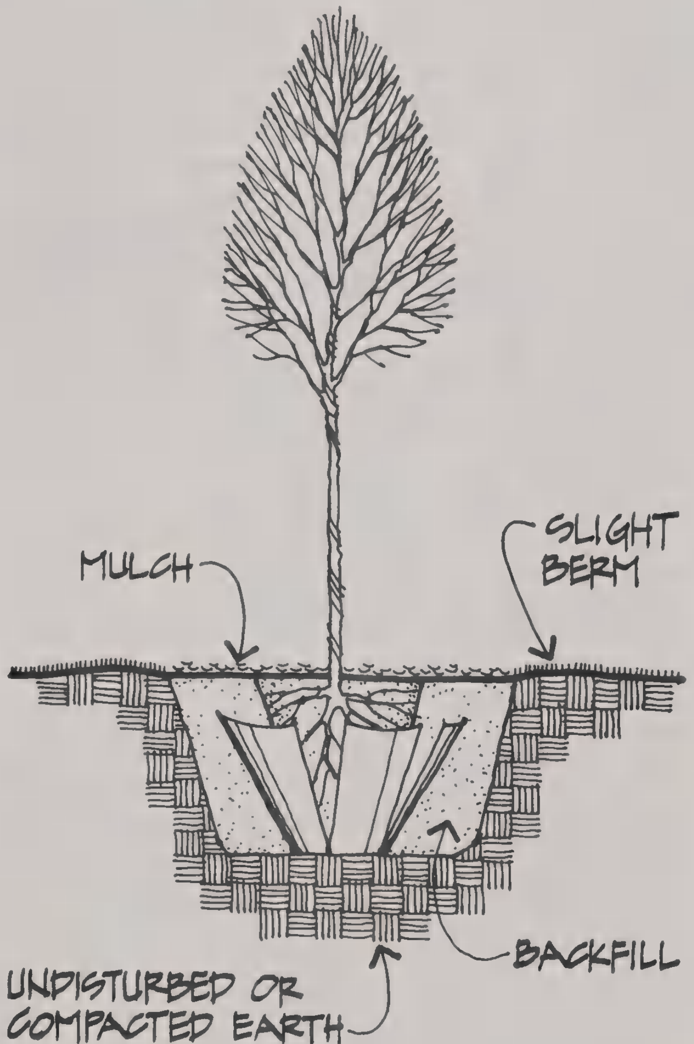


Figure 9-9. Planting a Container-Grown Tree-Remove Container Prior to Backfilling Hole

After loosening crowded roots, check to make sure that the top of the root ball is at or slightly above grade. Adjust it so that it is vertically plumb and facing the right direction. Follow the same procedures for backfilling, watering, mulching and pruning which were previously described for planting balled and burlapped trees.

Bare Root Trees

The roots of bare stock should be received in wet burlap or sphagnum moss or other organic materials to prevent drying and mechanical injury prior to planting. If received before the day of planting, they may be stored in a cool, moist place for several days. They may also be "healed in" for several weeks if necessary. To heal trees in, untie the bundles and put roots in loose, moist soil or mulch. Line the trees in a row and lay them at a 30 to 45 degrees angle with the tops of the plants facing south. Shade them and keep them cool.

The planting hole should be large enough to easily accommodate the roots when spread out without cramping, bending or cutting them. A large pedestal of soil should be formed with the backfill. Lower the plant into the hole and place the base of the trunk on the crown of soil. Spread the lateral roots evenly over the pedestal. Adjust the plant's depth so that the old soil line (often visible near the base of the trunk) will be at or slightly higher than the surface level of soil surrounding the planting hole. Face the graft union to the north to prevent damage from direct exposure to the sun's rays. Add soil gradually, firming the soil around the roots with your fingers. Fill the hole with soil and then water thoroughly. If settling occurs, or the plant is not plumb, readjust the plant by grasping the base of the plant just above the roots and gently rocking it while pulling up. Then add the remaining soil to grade and water the plant again. Because bare root stock has very few feeder roots, it is often recommended to prune the tree to restore nutrient and water balance in the tree. Many have recommend removing up to one-third of the crown on larger deciduous trees after planting them. However, research suggests that trees establish themselves faster if little or no pruning is done. Experience may suggest how much and where to prune but consider the arguments against pruning made previously in this chapter.

Water the new transplant conservatively until new growth appears. Dormant plants need much less water than actively growing ones and do not rapidly form new roots in wet soils. Check the soil for dampness before watering. If the subsoil is damp do not water. If hot, dry weather follows planting, it may be necessary to cover the trunk of the new plant with burlap or other wrapping material until it begins to grow. Frequently, bare root transplants are slow to leaf out, so do not give them up for dead prematurely. Figure 9-10 illustrates the recommended method of transplanting bare root stock.

Planting In Pavement

Planting trees in business districts, plazas, malls, and similar areas with heavy pedestrian traffic can be difficult and expensive. These areas are typically paved with concrete or asphalt and are generally inhospitable to plants. Soil aeration, fertility, and water infiltration are either nonexistent or minimal. Planting in this harsh environment requires specially designed tree pits.

If there is ample space, the recommended procedure is to plan for or cut an opening in the paving that is approximately as large or larger than the anticipated spread of the tree canopy. Excavate the subgrade materials and backfill the

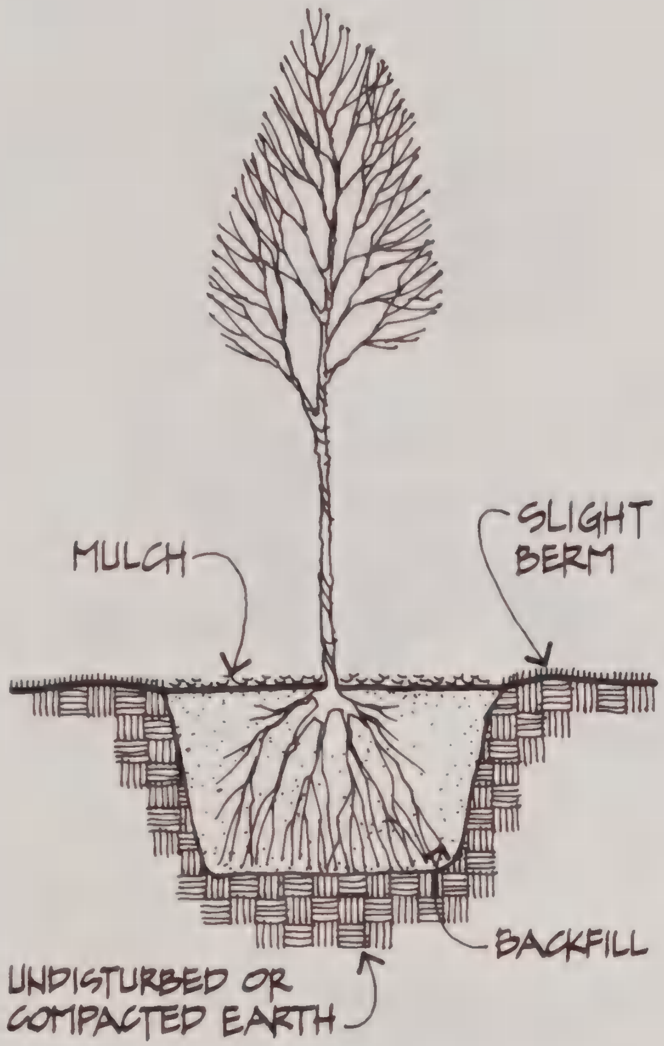


Figure 9-10. Planting a Bare Root Tree

opening with planting soil as described earlier in this chapter. In areas receiving moderate foot traffic, turfblock or engineering mat can be laid down on top of a prepared base over the backfill and the area seeded with grass. In areas of heavy pedestrian traffic, modular paving materials such as precast pavers, brick or cobbles can be used. Set modular pavers on 2 to 4 inches of sand adjacent to trees and over the top of root areas. This allows water, air, and nutrients to reach the roots. However, in many urban situations, business districts, and parking lots, foot and vehicles traffic is heavy and space is at a premium. Poured paving to within 24 inches of the trunk is the common although minimal standard. Consequently, small planting pits with tree grates or precast collars are typically specified. Although not ideal, trees can survive and grow — albeit slowly — under these confined growing conditions. Two examples of very sophisticated tree pit designs are illustrated in Figures 9-11 and 9-12.

Europeans successfully grow trees to maturity in excavated soil pits and long trenches surrounded by concrete. The pits are well drained, filled with coarsely aggregated soil and fitted with 2-3" diameter perforated irrigation tubes (Figure 9-13). The surface of the pit, in areas where foot and wheel traffic are heavy, is cobbled in 2-4" of sand. The surface may also be mulched, planted with a ground cover or be left for a sward to grow where traffic is not excessive and adequate moisture is available.

As discussed by Urban, the larger the soil volume, the greater the potential root growth (See Figure 8-6). Consequently, the tree is subject to less water and nutrient induced stress and grows faster and larger. To expand the rooting volume, Urban suggests expanding the excavated soil pit under the sidewalk and surrounding cement, where possible (Figure 9-14).

Trees that have been growing well, surrounded by concrete have root systems that have "broken out" from the original excavated planting hole into surrounding soils, increasing their water and nutrient absorbing capacities. It is adviseable to create root "break outs" by design. A space under sidewalks, walls and other cement structures (See Figure 9-14) to allow roots to grow into adjacent soils such as parkways, planting beds, lawn areas, greenbelts, etc. Providing well constructed break out channels for roots to escape the cement bound planting pit improves by many fold the tree's chances of survival and potential for normal, rapid, healthy growth.

As shown in Figures 9-11 and 9-12 cement casings and tree grates are often recommended, along with metal trunk protectors, to cover the surface of the planting pit. Effective in preventing soil compaction and reducing vandalism to the tree trunks, this hardware is very expensive and ends up damaging trees and restricting growth after several years. The problem? Maintenance crews and city budgets do not provide replacement grates and cement covers with larger trunk openings and as the trunk grows it becomes girdled by the existing cover. Sand bedded paving bricks are a less expensive and nondamaging alternative. Likewise, metal trunk protectors damage trunks or lower limbs they were originally designed to protect. Do not use these types of hardware when planting trees in cement bound planting areas.

In addition, the interface boundary between the planting soil surrounding the root ball and the selected material for the tree pit may be a barrier preventing root growth into the entire area of the pit (See figure 9-12). Another interface below the root ball will slow water movement, reducing the drainage and aeration conditions required for root growth. When possible the tree pit should be designed to allow apporximately one foot of radial root space per inch of trunk diameter at maturity.

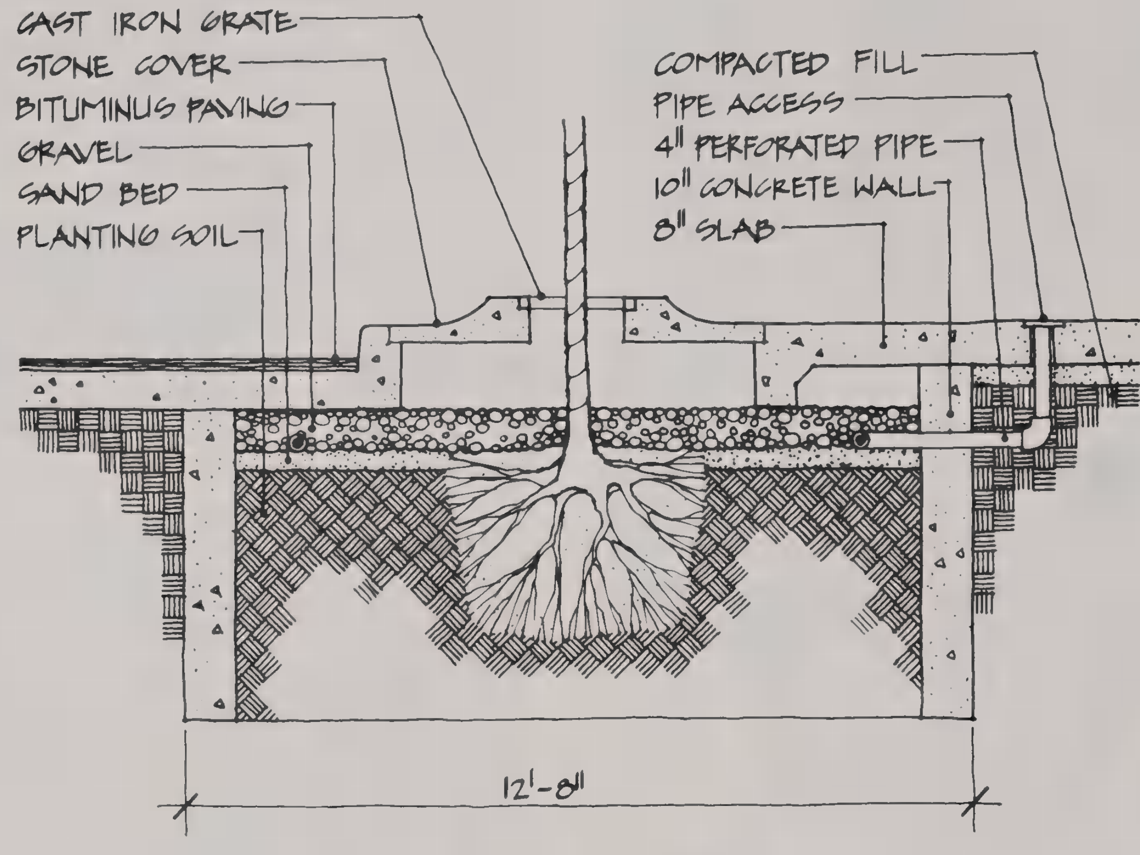


Figure 9-11. St. Paul Minnesota Tree Pit. Redrawn from Original by Linda Jewell

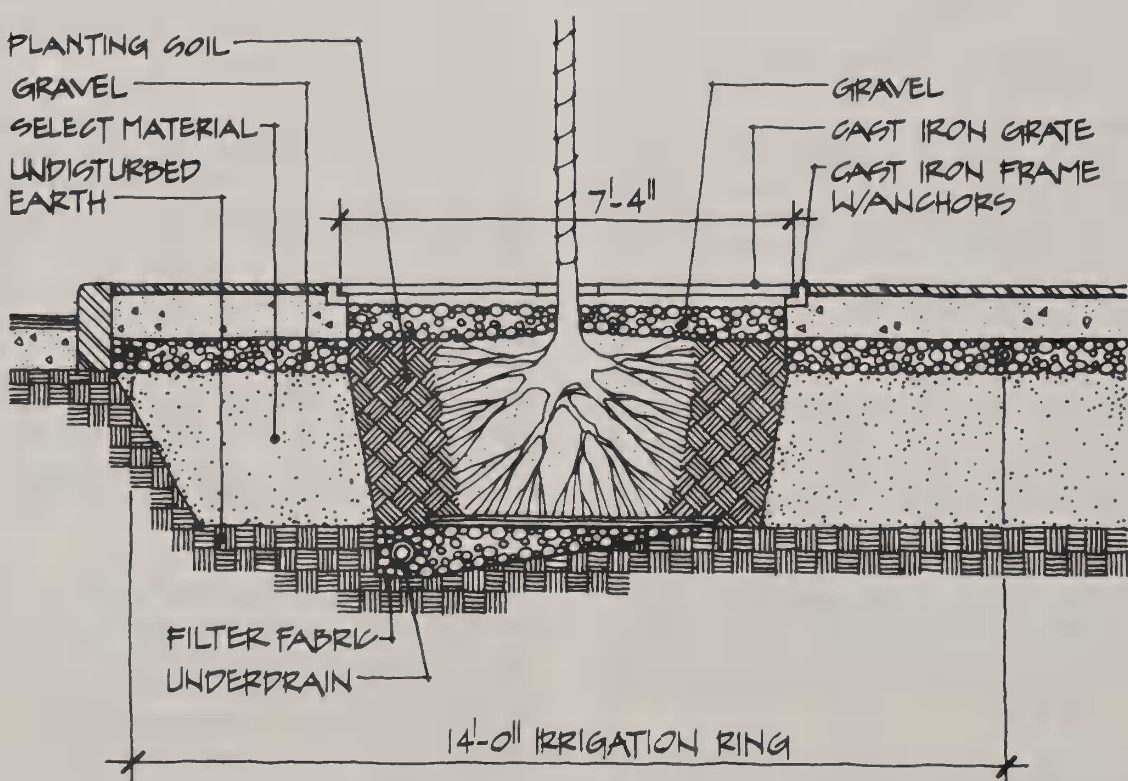


Figure 9-12. Pennsylvania Avenue Tree Pit. Redrawn from Original by Linda Jewell

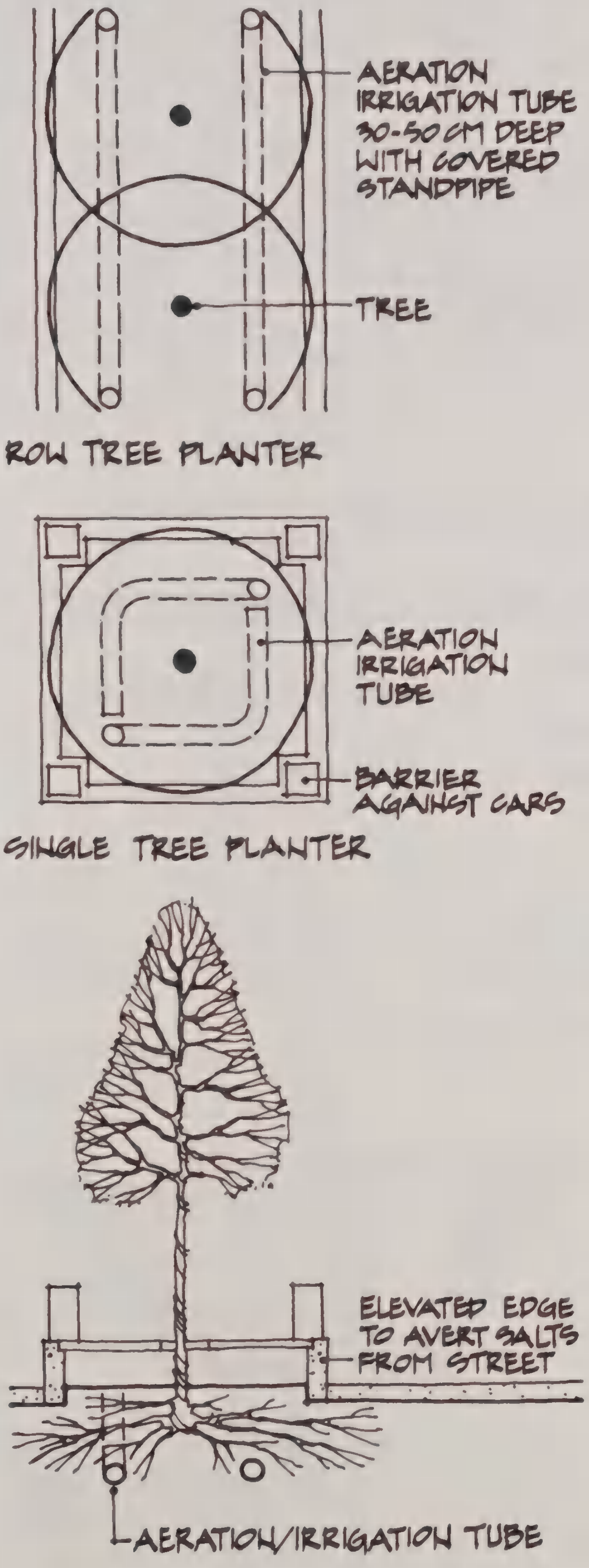


Figure 9-13. Planting Pits with Perforated Irrigation Tubes

Field Transplanting

A number of things, such as demolition or new construction, may make it necessary to move small trees from one area to another. This can be done relatively easily if the tree is less than 2" caliper. Because special equipment is needed to move larger trees, rely on a professional to transplant them. Field transplanting, a complex procedure not frequently done in most cities of this region, will not be discussed in detail. For more information, purchase the up-to-date transplanting manual entitled "How to Transplant Trees and Shrubs" from the International Society of Arboriculture.

Anti-Transpirants

Anti-transpirants (also called anti-desiccants) reduce the loss of water from the leaves of evergreen and deciduous trees. Most anti-transpirants are liquid plastics that are diluted in water and sprayed on the foliage and stems with a pressure sprayer although some are available in small quantities in aerosol cans. Many anti-transpirants contain a green dye.

Anti-transpirants are commonly sprayed on evergreens and deciduous trees in leaf prior to transplanting. They are used more for relocation of trees than for planting nursery stock. They are also sprayed on the foliage of trees that must be transported long distances in an open vehicle. By inhibiting water loss, anti-transpirants assure more successful tree transplants, especially during the growing season. However, "it should not be considered a substitute for good gardening practices. Carelessly handled trees and those with poor root systems will not survive transplanting nearly so well as those that are properly handled and have an adequate root system." (Pirone, 1978, p.52).

Staking

Newly planted trees should be staked only for any or all of the following three reasons: to protect the trunk from being injured by equipment, vehicles and vandals; to anchor the root system; to support the trunk in an upright position. Otherwise, do not stake trees! Many times trees arrive at the site with a stake inserted in the container. These stakes should be removed. The following recommendations, taken from "Staking Landscape Trees" (Harris, Leiser, Davis, 1969 and Harris 1983), offer tree staking techniques for protection, anchorage and support.

Protection

Trees without low laterals or with shallow roots and planted in areas where power mowers or vehicles are likely will be damaged and require

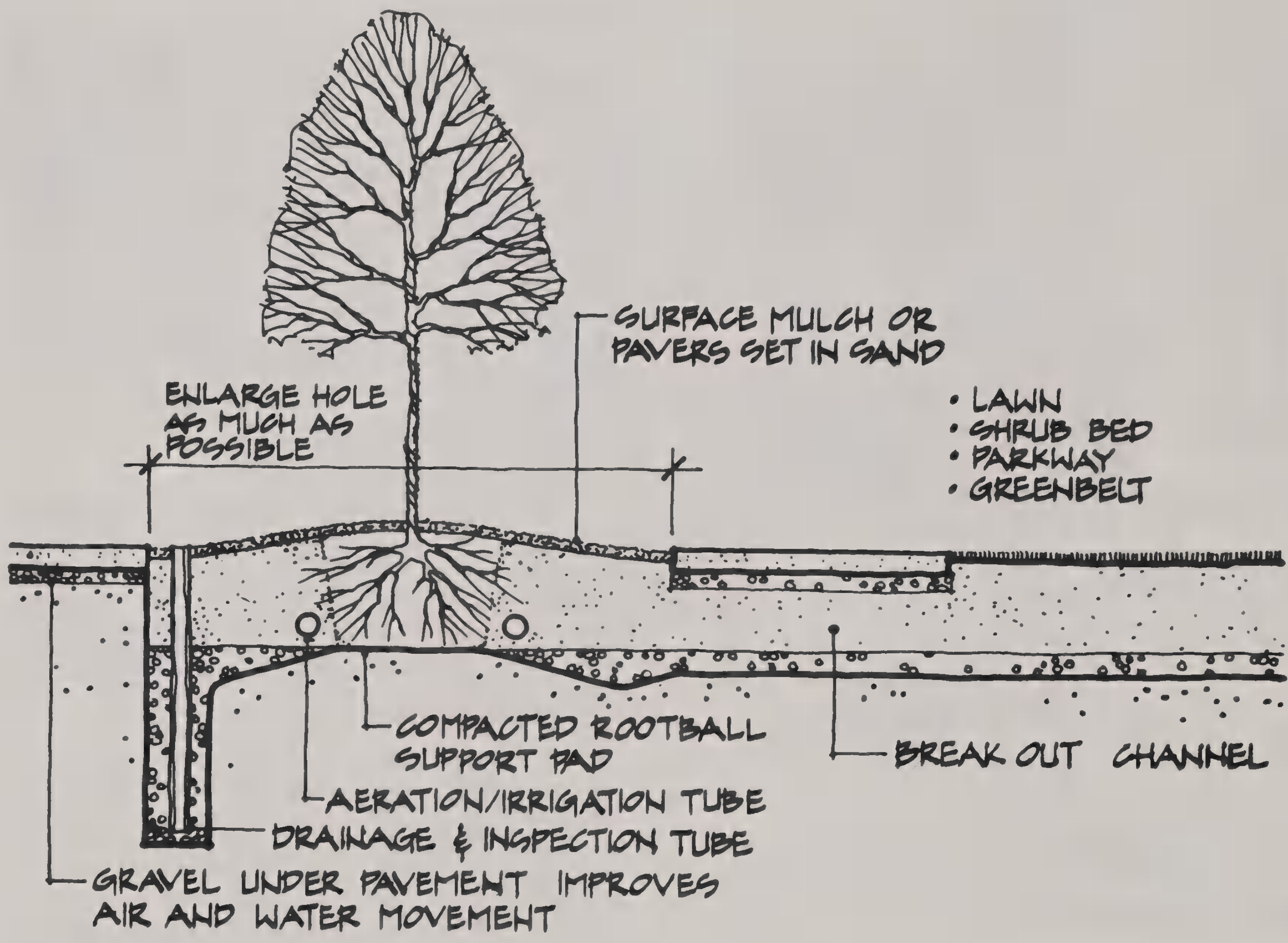


Figure 9-14. The American Forestry Association proposes new tree-planting techniques that allow roots to expand beneath pavement and water to drain properly. Moll and Urban, AFA, P.O. Box 2000, Washington, DC 20013

protective staking. Vandals can damage staked trees more easily -- stakes serve as a fulcrum over which to break the tree. Three stakes should be driven at least 18 inches into the ground at the edge of the root ball. Three-foot stakes painted white or florescent orange are less likely to be tripped over or struck by vehicles than short ones. Consider mulching around the tree to minimize weed and grass trimming needs.

Root Anchorage

Frequent high winds and irrigation required for young trees accentuate the instability of the root system. Well anchored roots are necessary if new transplants are to grow well with upright trunks.

The three stakes suggested for protecting tree trunks not needing support can provide adequate anchorage for the roots if tied to the tree trunk as low as possible with a flexible web belting. **Remove the ties at the end of the first growing season, leaving the stakes to protect the trunk.**

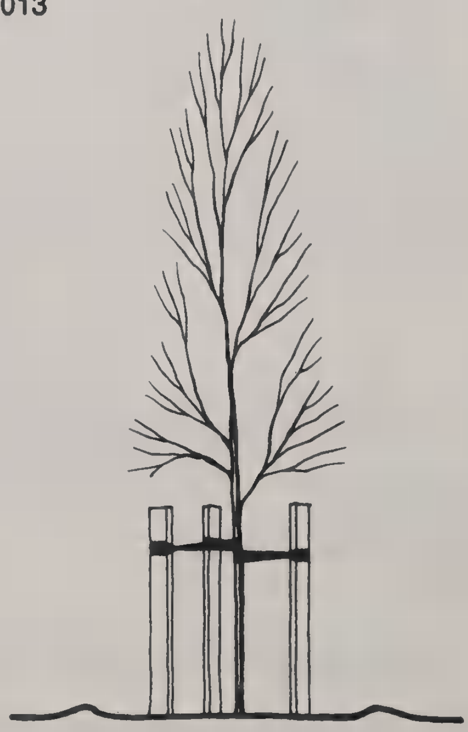


Figure 9-15. Staking for Protection and Anchorage

Also, reduce the weight and wind resistance of the tree by thinning the top. A tree staked for protection and anchorage is shown in Figure 9-15. With proper (deep) irrigation, the tree should not require staking in its second season.

If protection is not needed, secure the root ball and support the tree with one stake. Drive a 2 inch square, tree stake at a 45 degree angle into the direction of the prevailing wind into the soil just missing the top of the root ball. Secure the trunk to the stake with a protective tie 1 to 2 feet above the soil. Developed by Tom Stille, this method of staking small trees, B and B and container stock smaller than 10 gallons in size secures the root system and supports the young tree as well (Figure 9-16).

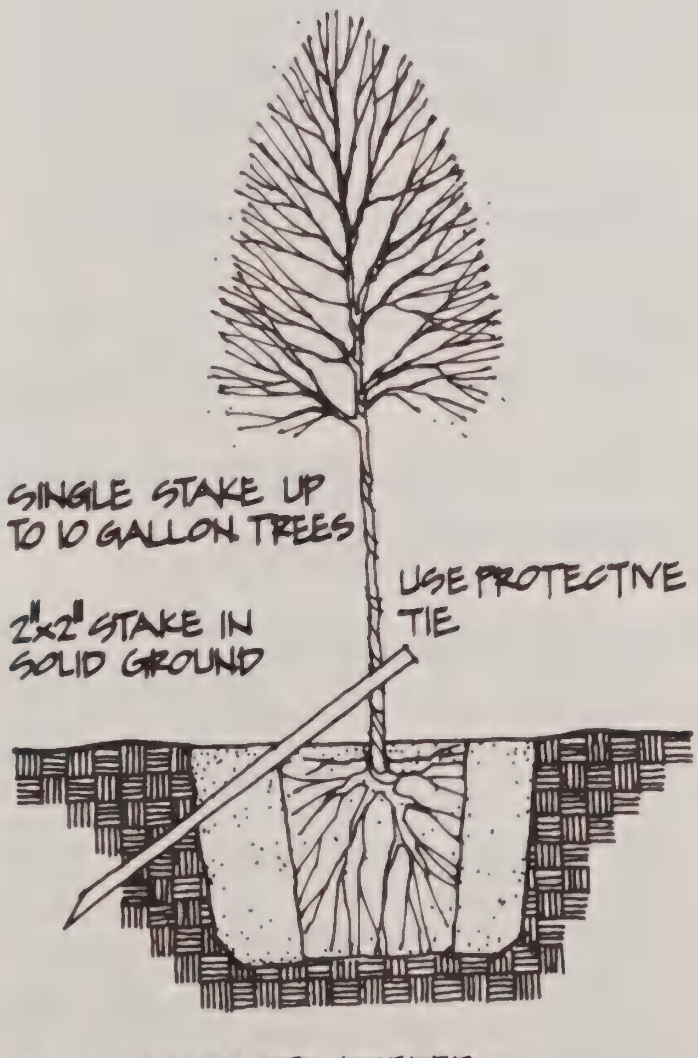


Figure 9-16. Staking to Stabilize the Root Ball. Designed by Tom Stilles

Trunk Support

Newly planted trees frequently require some protection from being bumped by cars, bikes, and children playing. **Top support for these trees should be as low on the trunk as possible but high enough so that the tree will return to an upright position after being bent.** To find the proper height, hold the trunk in one hand, pull the top to one side and release. The height at which the trunk will just return to upright when the top is released is the height at which ties should be attached (See Figure 9-17).

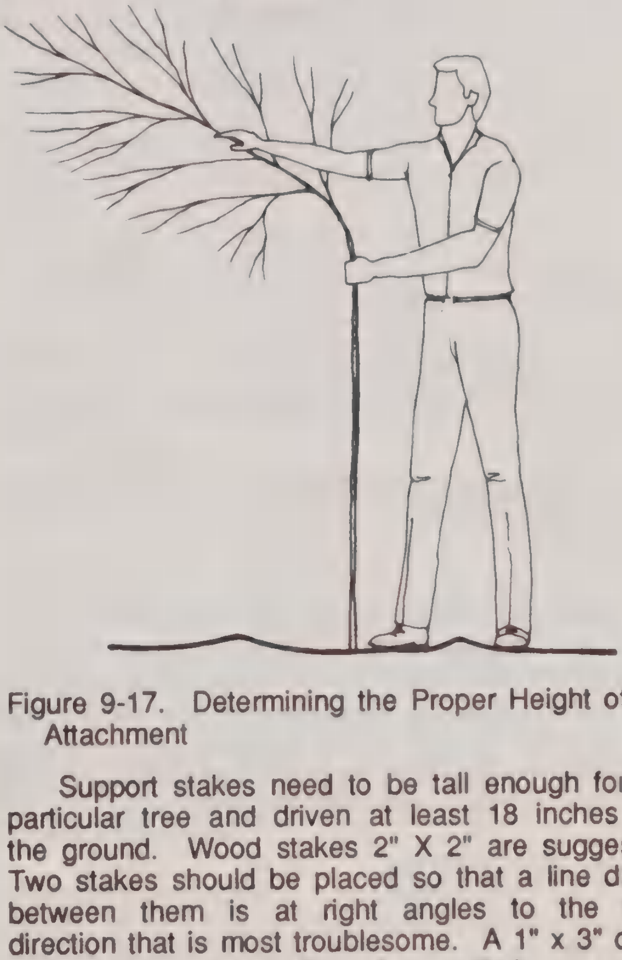


Figure 9-17. Determining the Proper Height of Tie Attachment

Support stakes need to be tall enough for the particular tree and driven at least 18 inches into the ground. Wood stakes 2" X 2" are suggested. Two stakes should be placed so that a line drawn between them is at right angles to the wind direction that is most troublesome. A 1" x 3" cross tie placed at the soil surface will increase the strength of the support stakes. It would be placed to the leeward of the stakes to lessen the risk of rubbing injury to the trunk. This is illustrated in Figure 9-18.

The tie should form a loose loop around the tree trunk, tied so that the trunk cannot move towards the support stake in a strong wind. Cut the stake off just above the tie so that the stake will not rub and damage lower limbs or trunk. Inspect ties periodically during the growing season for slipping, breakage, untying or girdling. Tie materials should contact the tree with a broad surface to minimize rubbing and have some elasticity to permit a small amount of trunk movement. Elastic webbing, polyethylene tape and wire covered with garden hose are commonly used.

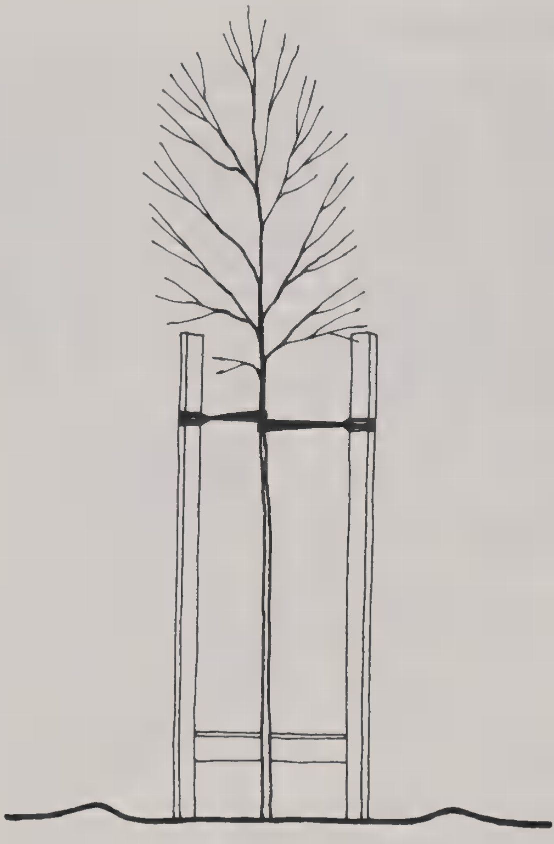


Figure 9-18. Proper Height and Arrangement of Support Stakes

Support stakes may be required for the first growing season and sometimes through the first winter. If the tree needs support during the second growing season, check the tying height as described earlier in this section. After lowering or removing the ties, shorten the stakes so that they do not rub against the tree trunk.

Tree Wrapping

There is some controversy as to the benefits and disadvantages of wrapping the trunk of a newly planted tree. The advantages of tree wrap include preventing sunscald, frost cracking and drying of the bark. The major disadvantage is that during the rainy seasons the trunk is kept unduly wet beneath the wrapping. This creates a dark, damp environment which encourages the growth of fungi and harbors insects.

The larger branches and trunk of a tree are wrapped with a special commercially prepared crepe paper or burlap. The tree should be wrapped from the bottom up and the tree wrap should overlap at least one-half its width as illustrated in Figure 9-19. The covering should be securely fastened in place with elastic tape and left on the tree over the winter, removed during the growing season, and replaced annually until the bark becomes fissured or until canopy shades the trunk. If summer sunscald is a problem, protect the tree during the growing season. Do not use woven plastic, nylon, twine, or wire to secure the wrap. All of these can girdle a tree. Where not objectionable, white latex paint has been effective in protecting thin-barked trees from winter sunscald. Do not use oil based paints.

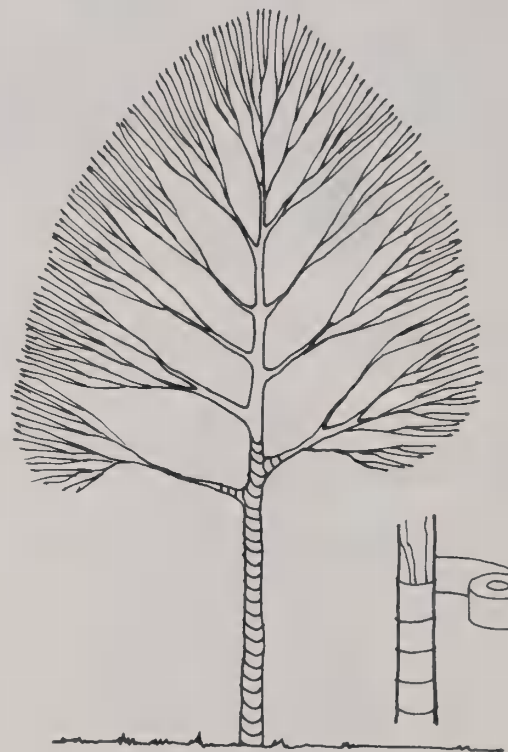


Figure 9-19. Recommended Wrapping Technique

Watering and Fertilizing

New transplants should be watered frequently during the first growing season to promote their establishment. In most of this region a deep soaking once a week in addition to normal lawn sprinkling is sufficient. Reduce watering during the spring and fall if it rains frequently. Over-watering drives oxygen from the soil, which retards root development and may suffocate the roots of the tree. Evergreens in particular, should be watered in the late fall after dormancy has set in to reduce the likelihood of winter desiccation.

Dry commercial fertilizers should not be applied during the first growing season. They may burn the young feeder roots or the roots may not be well formed and able to absorb the nutrients. Slow release fertilizer tablets may be set in the planting hole near the roots before backfilling without harmful effect to the tree. After trees have been in place for a year, they may be watered and fertilized as described in Chapter XII of the Manual.

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X. XERISCAPE

Water Conservation Through Creative Landscaping

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Water Conservation Through Creative Landscaping

XERISCAPE

Nationally, communities have been faced with increasingly more difficult demands regarding water –its supply, quality, distribution, purification, management, and associated costs. Potable water is becoming scarce and the costs of building delivery systems and water treatment plants prohibitive. Consequently, cities are forced to conserve water, not only during droughts, but to reduce demands of peak loading on systems in an attempt to delay construction of larger, expensive facilities. Saving water saves energy while conserving other valuable resources. Of course, there are numerous reasons for communities, particularly those of the semiarid west, to conserve water, but these are several of the most pressing.

Water conservation takes on two broad aspects. First, efficient manipulation of **physical factors** in the landscape — delivery and irrigations systems, soils, percent hardscape used in a design, plants, microclimates, mulch, etc. Secondly, the **people factors**, which are often more important. Historically, the United States was settled from the east to the west. The settlers found pure water plentiful and developed lush, green landscapes after a European philosophy of design unrestricted by water.

> Thus, along with the birth of America was born a cultural attitude and tradition of water as a limitless resource, the exploitation of which being only limited by the peoples' ingenuity and efforts.
> — Robert L. Thayer, Jr. and Thomas Richman, 1984

The concept of a limitless supply of high quality water has been perpetrated by water companies and governments with pricing schemes which charge less for increased water use by consumers, especially industrial users. They also have acquired subsidies or long term bonding for constructing water delivery and clean-up systems and have not attached all of these costs to water fees. The true price of water is often lost in municipal overheads and subsidies and not directly charged to water. Consequently, per capita water use has continually increased, and those with high incomes tend to use the most water.

The incorrect perception that water is "cheap" or "inexpensive" has led to the ideas that the water supply is not finite and that it flows towards money. This in turn has fostered a national consciousness that high water use landscapes are normal, desirable and acceptable. Little has been done to change this mind set, particularly as it relates to water conservation in the landscape. With the increased, continuous demand for high quality water exceeding supply of both surface and below ground sources, a new, national philosophy for conservation must be engendered: billing must reflect the real costs of water and people must learn and practice the "whys" and "hows" of water conservation. This is why Xeriscape began.

Xeriscape Defined

XERISCAPE (zir' i scap) is an integrated approach to landscape water conservation. Xeriscape was coined from the Greek word "xero" for dry. Thus, Xeriscape means **dry**scape or low water use landscaping. Xeriscapes are designed through wise planning, plant and construction materials selection, and proper installation to provide beautiful, water efficient, low maintenance landscapes.

Many have misread the term as **zero**scape, which would imply noscape or no landscape plantings. Others have equated xeriscape landscaping with "rockscapes," many of which are not aesthetically pleasing and may not always conserve water or energy if they increase the cost of residence heating, cooling, and cleaning. Rockscapes are harsh, produce glare, and do little to prevent noise and air pollution, making them a poor substitute for Xeriscape landscaping.

Xeriscape Goals

The ideas for Xeriscape came together in 1981 as a cooperative effort between the Denver Water Department and Colorado's green industry, including the Associated Landscape Contractors. The Front Range Xeriscape Task Force, a volunteer group of forward-thinking individuals from these groups, has continually supported Xeriscape program development. The National XERISCAPE Council, Inc., a non-profit organization, was established to provide public service educational programming for water conservation and landscape improvement on a national basis. Goals include:

* Promoting water conservation through creative and sound horticultural practices.

* Promoting, conducting, and/or assisting research related to Xeriscape concepts for better water use efficiencies.

* Facilitating greater exchange of information between the landscaping profession, water utilities, governmental agencies, and the general public. Assisting communities in program start-up and continuation.

* Increasing development and use of lower water using plants and landscape materials.

The National XERISCAPE Council, Inc., headquarters were moved to Austin, Texas, for day-to-day management and monthly publication of Xeriscape News, the official publication of the NXCI, by Association and Society Management, Inc. The word "Xeriscape" and the Xeriscape logo have received trademark rights. Authorization for use of both in educational water conservation programs may be requested. If you have questions about the National Xeriscape Council Inc., the use of its trademarks, programs, or newsletter direct them to the NXCI, 940 E. Fifty-first St., Austin, Texas 78751, 512-454-8626.

Seven Water Conservation Fundamentals

The Xeriscape motto, **"Water conservation through creative landscaping,"** provides the umbrella under which a wide variety of landscape water conservation activities may be taught and employed in a community. And although there are many landscape and horticultural techniques that conserve water, Xeriscape programming has focused on seven broad, fundamental areas.

1. Planning and Design
2. Soil Improvement
3. Efficient, Zoned Irrigation
4. Limited Turf Areas
5. Use of Mulches
6. Use of Low Water Demand Plants
7. Appropriate Maintenance

Planning and Design

Architects, planners, and homeowners are encouraged and taught to incorporate standard design elements of function, circulation, topography, exposure, seasonal color, texture, safety, etc. into existing landscapes and new designs with emphasis on conserving, limiting and/or reusing water. Throughout the western U.S. 40% to 60% of the water homeowners use during the growing season goes for yard watering. Cities, as well, utilize large quantities of water for parks, swimming pools, fountains, arboreta, golf courses, athletic fields, and other recreational facilities. Appropriate design and planning can provide these very necessary aspects of urban life and conserve water at the same time. In arid and semi-arid regions where good water conservation planning must be employed, Xeriscapes can ameliorate the impact of a severe drought and avoid the costly clean-up resulting from a "boom and bust" water policy. Tree removal, replanting of landscapes and turfgrass fields are eliminated and real savings to city coffers incurred.

Thayer and Richman (1984) suggest that designing water-conserving landscapes should be considered in two parts. First, the physical ecology of plants and plant communities must be integrated within the microclimates of the landscape. Logically, plants best adapted to the climate, temperatures, sun, wind, and physical nuances of the site thrive best and require the least expenditures for water, energy and maintenance. Secondly, landscape designers must accept that there is a "human ecology" of water use in landscapes. That is, the intensity of human activity dictates landscape water use. This includes all uses, whether functional or aesthetic. Thayer and Richman coined the term "hydrozone" to describe the type and intensity of human activity in the landscape and identified four classes of hydrozones. These will be discussed under the heading "Efficient, Zoned Irrigation".

Soil Improvement

City soils are difficult soils to manage because they have been badly disturbed by construction and urban activities. Normal soil horizons are mixed unevenly both vertically and horizontally. Often, hardpans or caliche exist and impede drainage, and most city soils have been compacted by heavy equipment or traffic. Many of the physical and chemical soil properties plants require for growth are present at less than optimum levels in city soils. Soil improvements must correct poor water infiltration, percolation, and drainage, while providing adequate water holding capacity and improving the nutritional status of the soil. Organic amendments meet most of these requirements and improve tilth, making it easier to till the soil and manage weeds. Adding 3-5 cubic yards of well composted organic matter per 1000 square feet and tilling it into the top 8-12 inches of soil is recommended.

Other amendments such as lime or sulfur may be added to adjust an undesirable acid or alkaline soil condition. Gypsum combined with leaching improves sodic soils often encountered in urban soils. These adjustments should be made prior to planting.

An urban forester must also be concerned with hardpans and caliche layers. These impermeable layers must be broken up prior to planting trees in order to improve drainage, prevent saturated soil conditions and allow deep root growth. Poor root growth, inadequate anchorage, and root rot diseases accompany trees planted over pans.

Efficient, Zoned Irrigation

Matching the amount of water supplied to each plant with the plant's water requirement is the most efficient way to irrigate.

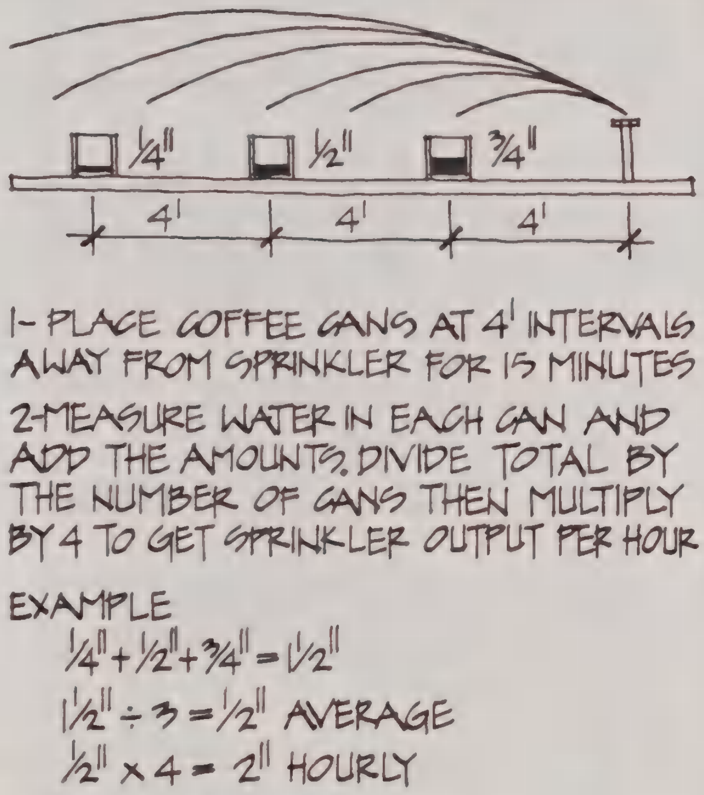


Figure 10-1. Irrigation Evaluation

Until recently this was difficult to do and most landscapes were irrigated to meet the needs of the turfgrass or other plants with high water requirements. Sprinklers cover large areas without regard to the water needs of individual plants. To eliminate waste by overwatering and run-off, group plants according to their water requirements and use zoned irrigation systems to deliver water to individual plants or to plants with similar moisture requirements (Figure 10-2). Fewer plants will develop disease or die from overwatering.

Not only are irrigation zones established to meet the physical or ecological water needs of plants, but Xeriscape landscaping also recognizes that human activity will impact plant water needs. Thayer and Richman (1984) describe this irrigation zoning to match man's activity as hydrozone planning, and they define four irrigation regimes (Figure 10-3).

The **Principal Hydrozone** represents the area with the greatest human activity and consequently the greatest water and energy use: sites in yards, parks, and play fields where people frequently, play, sit, walk, gather, or relax; places where people regularly contact plants.

The **Secondary Hydrozone** is less physically impacted by humans, but is visually important: areas of passive activities, space delineation, or focal interest such as flower and shrub beds, entrances, prominent plantings, etc.; areas of high visual impact, but seldom touched by humans.

Buffer zones, distant views, median strips, parkways, and embankments — these make up the third hydrozone, called the **Minimal Hydrozone.** In this case, plants are selected that need minimal supplemental water to survive the natural climatic conditions.

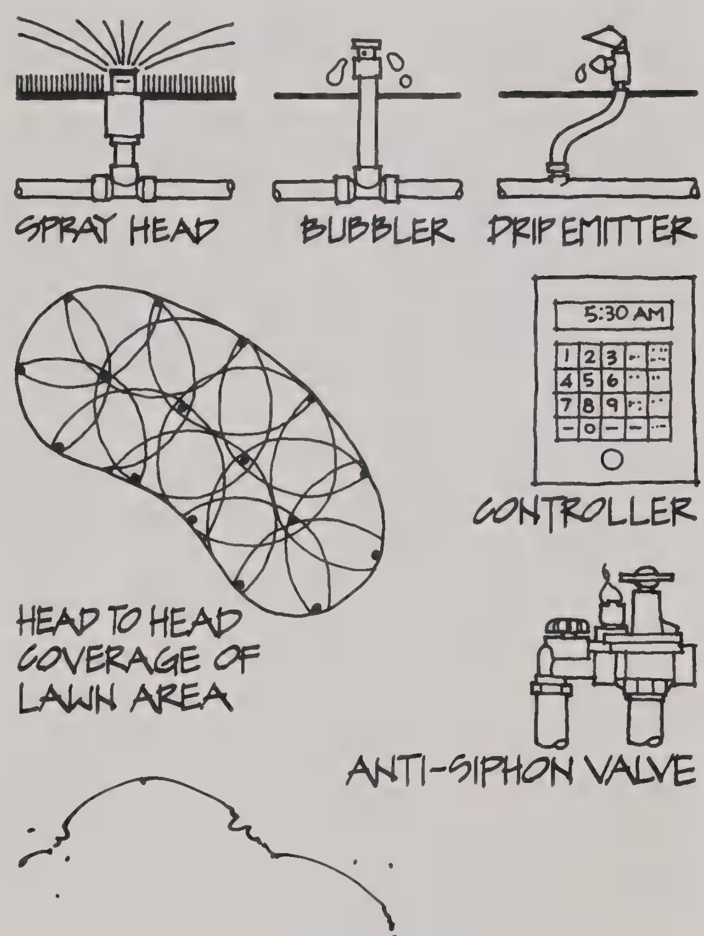
The **Elemental hydrozone** constitutes landscape plantings that require only natural precipitation to survive and seldom, if ever, incur human activity. Utility areas, mulched native plantings, and naturally sustainable, exotic vegetation belong to this hydrozone (Figure 10-4).

Flexible sprinkler heads and nozzles, adjustable delivery rates and coverage, modern valves, and automated controllers — these allow greater water conservation through zoned irrigation. On-off watering is easily programmed to match water infiltration rates into soils, thus avoiding surface runoff. Also, water is better applied to meet specific plant needs as impacted by seasonal human activity and changes in the weather.

Collection systems should be designed and constructed throughout the landscape to gather storm runoff from roofs, walks, drives, and slopes. By grouping high or moderate water requiring plants near swales and collection basins, much of their water needs can be met by natural moisture accumulations rather than irrigation. On the other hand, drought tolerant species may succumb to frequent accumulations of water and should be located on southern exposures or at the tops of slopes. Because they often only require supplemental irrigation during establishment or during a severe drought, a permanent irrigation system may not be needed.

Limited Turf Area

Turfgrass plays a primary role in most landscapes. Turfgrasses make excellent ground covers. They tolerate heavy foot traffic in the backyard, at the park, or on the athletic field. And mowed or unmowed, they stabilize slopes and prevent erosion. They serve to unify designs and instill a sense of pride in home and neighborhood when well kept. Moreover, turf helps keep homes and communities cleaner by reducing particulate and chemical air pollution. Unfortunately, a lawn consumes approximately half the landscape water and requires weekly care. As well, equipment, pest control and periodic cultural practices, such as coring or dethatching contribute to the expense, both in time and money, of maintaining a lawn.



1. Separate irrigation lines into high, moderate and low water-use zones or areas and set an automatic valve at the head of each line. The same plant material on the north side of a structure or in a sheltered area will require less water than in a more severe exposure.

2. To help achieve uniform water distribution for turfgrass, overlap sprinkler spray patterns (100%) so that water from one head reaches out to the next nearest head (head-to-head coverage). Ask your irrigation supplier for low gallonage sprinkler heads that have "matched precipitation rates."

3. Wire each valve into an automatice timer to control how many minutes each valve applies water. Select a timer that allows recycling, that is, several cycles of on/off "runtime" during each irrigation day. Heavy soils, clays, require several hours between short on periods to allow water to move deeper into soils. Sandy soils require less time between on times and may require mulching to enhance water retention qualities.

4. Prepare and follow an irrigation schedule by contacting a local landscape architect or irrigation specialist. Determine the precipitation requirements for your particular trees, shrubs, lawn and flower beds and program the timer to meet their individual water requirements. Settings will have to be changed seasonally to meet the plants demand for water.

5. Prevent surface run-off by adjusting heads to eliminate over spray on hard surfaces; reduce misting by spraying larger water droplets; utilizing on/off cycling; reducing slopes; using low preciptation heads and applying mulch whenever possible.

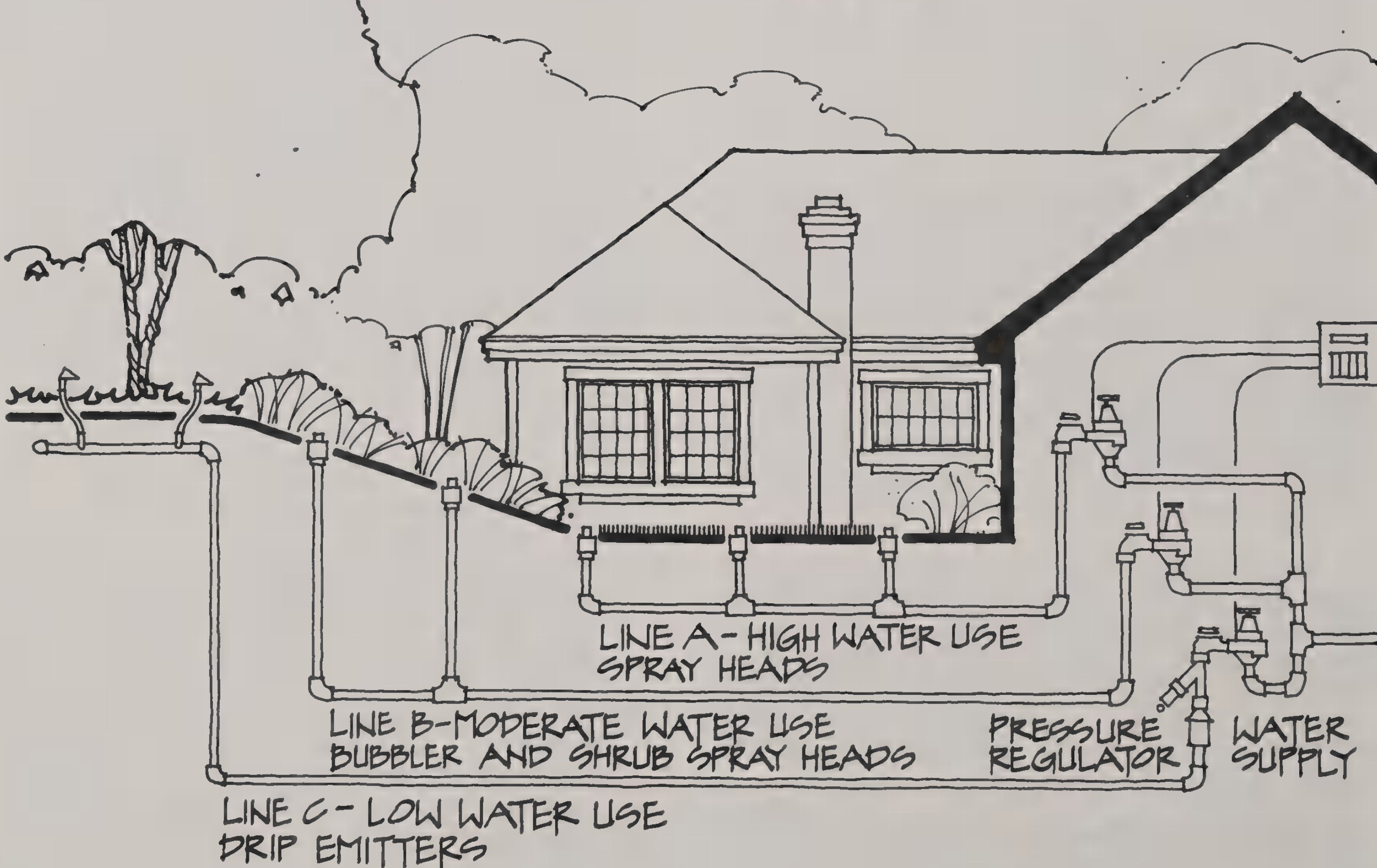


Figure 10-2. Five Steps to Efficient Irrigation

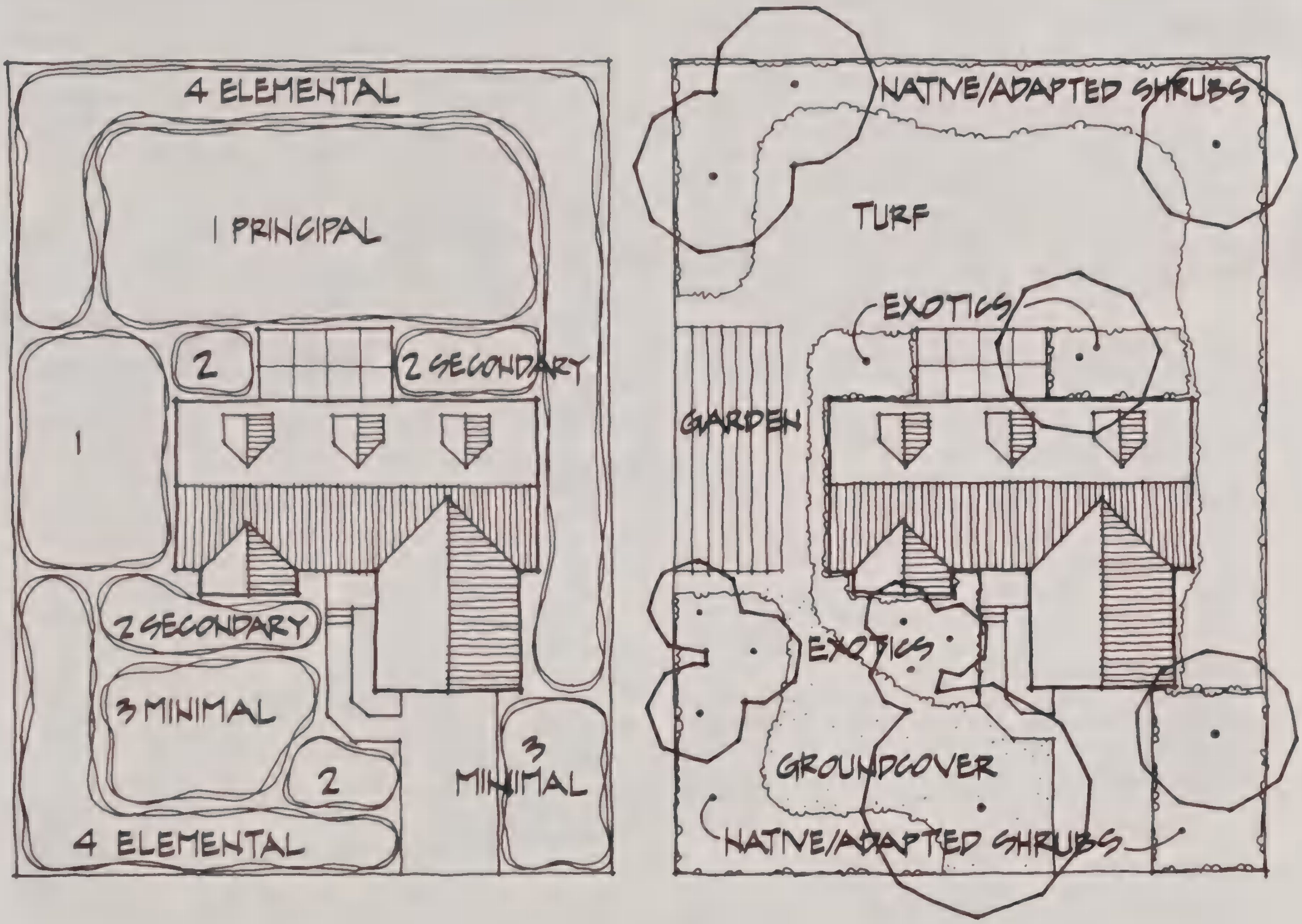


Figure 10-3. Hydrozone Concept Applied to Suburban Lot

Turf should be limited by design to high-use areas in landscapes and separated from other plantings with different water needs. After reviewing the landscape plans, classify the turf areas as either passive or active use and seed and irrigate accordingly. Plant drought-tolerant species with poor resistance to heavy traffic in less-frequented sites.

Not only should the total turf area be reduced in a landscape, but the perimeter measurement also must be reduced as much as possible. Long, narrow strips of turf are difficult to properly mow, fertilize, keep pest free, and irrigate. Such strips require hand work to keep them attractive, which increases maintenance time and labor costs. Water from over-spraying turf in narrow planter islands, parkways, side yards, and around entrances not only runs off and is wasted but also contributes to the deterioration of paint, walls, walks, and asphalt in parking lots and streets. Mulches or groundcovers and shrubs on drip or underground irrigation can appropriately replace turf in many landscape sites. Drip emitters or bubblers can be used to irrigate individual plants and eliminate waste caused by overspray. Mulches need no water, and well chosen groundcovers require less water and maintenance than turf.

Likewise, the amount of turfgrass in a landscape may be reduced by increasing the hardscape. Patios, wooden decks, rocked and graveled walks limit the turf area while reducing the water requirement.

Use of Mulches

Mulches function to buffer soils against climatic extremes. In summer, they reduce soil heating and slow evaporation water loss from soil surfaces. They also reduce weeds and make those present easier to remove. Proper use of mulches reduces or prevents soil erosion. Organic mulches also contribute to the nutritional level and tilth of the soil as they breakdown. In winter, they prevent daily freezing and thawing of soils, thereby protecting shallow roots of trees and shrubs from

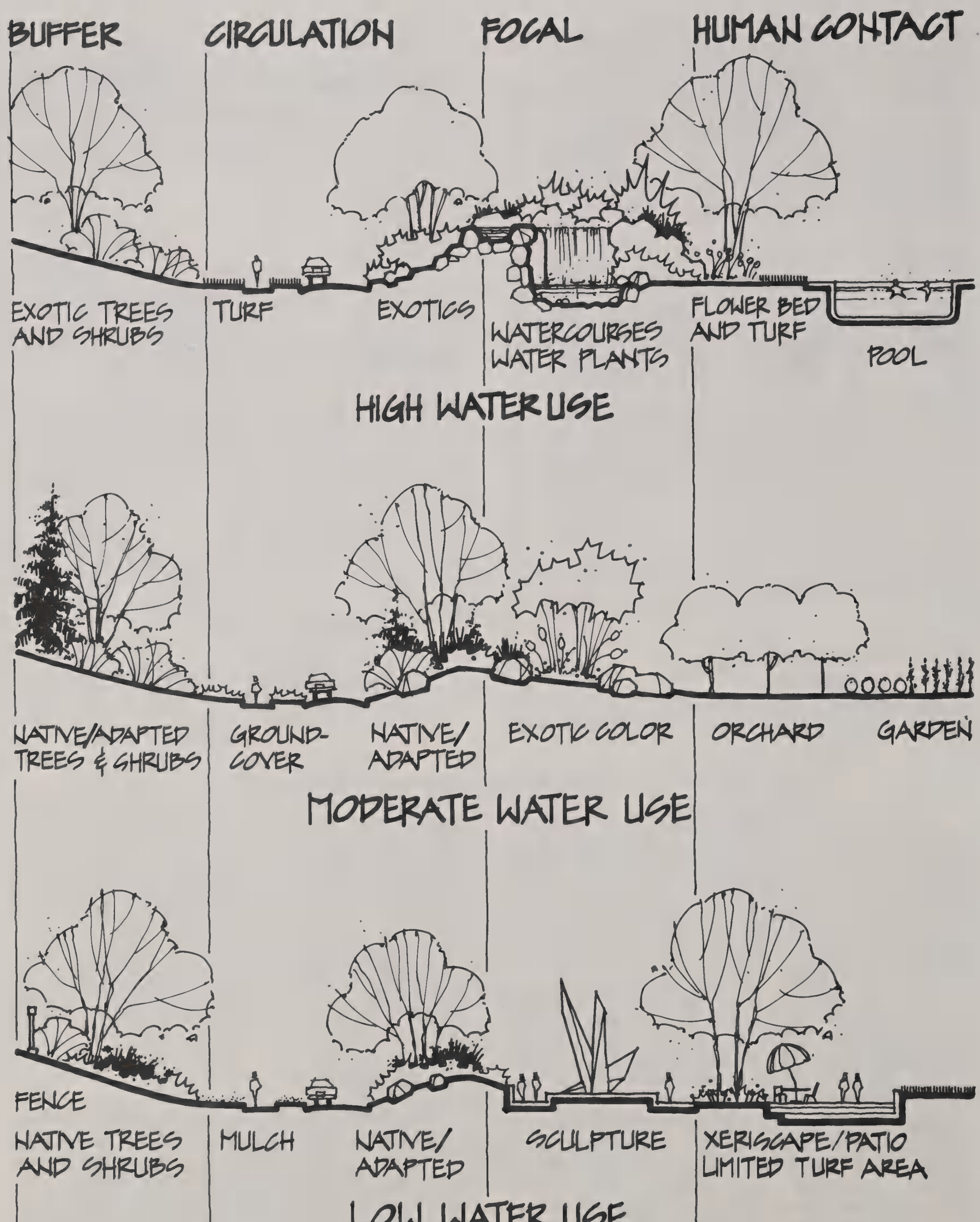


Figure 10-4. Water Use Relating to Human Use—Three Approaches

damage and death. During winter warm spells, they also prevent drying of soils and desiccation of roots. These practical functions are important; however, many mulches are included in the landscape for their design flexibility and attractiveness, not simply because they save water, protect roots, and reduce maintenance.

Mulches are classified as organic, inorganic, and living. Organic mulches include plant refuse, such as chips and slash from tree trimming operations, saw dust, composted leaves and manures, peat moss, and graded bark products. Sized and washed rocks and gravels are popular inorganic mulches which come in many sizes, colors, and textures. Impervious sheet plastics covered with either organic or inorganic mulches were popular, but because sheet plastic prevents gas and water exchange between air and soil and creates a water-logged root environment, woven, porous plastics are now preferred. Mulches are applied 3 to 4 inches deep over bare soil and only 2 to 3 inches deep over woven fabrics. Living mulches include low growing groundcovers and low maintenance turfgrasses. They function well as mulches, but may be heavy competitors for water and nutrients under newly planted trees and shrubs. If used, select hardy, drought-tolerant species that resist common diseases. These species provide the best results and require less maintenance.

Use Of Low Water-Demand Plants

Many beautiful and functional plants, both exotics and natives, are available that thrive with natural precipitation or small amounts of supplemental water. (See Tree Selection Matrix in Chapter IX for details.) All types of plants with low water requirements are now available and more will become available as demand increases. The range of drought-tolerant plant species and those with low water requirements is now wide enough to permit selecting for function, beauty, and seasonal interest. As with all plant selections and planting, take care to match the specific needs of the plant to the environmental conditions and the intensity of human activity at the planting site. This is critical when using drought tolerant and low water use plants in the landscape. Choosing the proper plants and planting them correctly will reduce water consumption and maintenance costs over many years.

Appropriate Maintenance

Low maintenance is not <u>no maintenance.</u> The use of all or most of the Xeriscape principles will reduce but not eliminate maintenance. And generally, the greater the human activity at a site, the greater its maintenance requirements will be. Trees, shrubs, groundcovers, and turfgrasses are living organisms that require care. Timely fertilizing, watering, pruning, pest management, and other cultural practices are necessary in Xeriscape landscapes, but at reduced levels compared to conventional landscape plantings. Even mulched sites without plants must have litter removed periodically. Irrigation components for drip and sprinkler systems require routine checks and servicing. Xeriscape landscaping coupled with sound maintenance produces water and energy savings and environmentally adapted landscapes that are aesthetically pleasing.

As has been stressed, integrating these principles in landscapes will conserve water and reduce annual maintenances costs. Most importantly though, Xeriscape landscaping provides these benefits without sacrificing function or beauty. And although these seven points are stressed in Xeriscape literature and are the basis for Xeriscape programming, there is no substitute for creativity as a means of discovering and sharing new ways to conserve water without making yards and parks into **<u>zero</u>**scapes.

Community education in Xeriscape landscaping is the key to a successful water conservation program. The principles of Xeriscape landscaping challenge the widespread but mistaken belief that water is a cheap, unlimited resource which will always be available. Hopefully, the public will recognize that this is a misconception and that water conserving landscapes are necessary and should be considered "normal" within our society. At the same time, it teaches people the "whys" and "hows" of effective water conserving horticulture. To reach these objectives requires the cooperation of government leaders, agencies, landscape professionals, horticulturists, irrigation specialists, concerned citizens, and an army of volunteers enthusiastically supporting and promoting Xeriscape programming.

Leadership and an Advisory Board

Who Does What? Private or municipal water purveyors — those responsible for delivering water provide the leadership and financial support for Xeriscape programming in a community. They also solicit support for water conservation from other organizations, businesses and individuals. Representatives from the green industry, city planning, parks and recreation, the Chamber of Commerce, Cooperative Extension, and other water conservation interest groups serve on an advisory board which oversees activity and educational program planning for the year. Following the board's goals and directives, staff from the water company in cooperation with other professionals and volunteers develops the programs and activities.

Xeriscape Programming

Xeriscape programming encompasses community awareness, community education, volunteer development, and demonstration/ research. These activities raise the consciousness and understanding of the community, which in turn leads to the development of incentive programs and new ordinances that encourage water conservation.

Successful Xeriscape activities and programs have included many creative ideas, some specifically tailored to unique programs and others teaching general principles. In each case, water conservation through creative, sound horticultural practices is taught. Examples include:

Community Awareness

* Television and radio programs, spots and public service announcements.
* Newspaper feature articles and garden columns.
* Video production and sales describing Xeriscape.
* Display boards, information booths, banners, and fliers made available to libraries, nurseries, garden centers, homeshows, fairs, service clubs, churches, and schools.
* Bumper stickers, banners, and signs for participants in Xeriscape activities to display.
* T-Shirts and memorabilia for fund-raisers and gifts.
* Neighborhood and individual Xeriscape participation awards and incentive programs for those who adopt Xeriscape landscaping.
* Narrated slide programs and video shows for loan.
* Speaker's Bureau Xeriscape presentations by volunteers to civic organizations, garden clubs, developers, businesses, planners, and others.
* Descriptive lists of low water use plants and how they can best be used in landscape water conservation.
* Tagged well adapted, low water use nursery plants with Xeriscape emblems to identify for the buyer which plants conserve water and require less maintenance.
* Maps that locate Xeriscape gardens and landscapes to visit.
* Program and informational inserts to include in monthly water statements.

Community Education

* Sponsor water conservation symposiums for various groups: planners and architects, municipal fathers and staff, green industry professionals, volunteers, and homeowners.
* Develop elementary and high school water science programs integrating Xeriscape principles.
* Hold irrigation and horticulture workshops for professionals and the general public.
* Write in-depth "How To" pamphlets, explaining best ways to accomplish the seven steps of Xeriscaping.

Volunteer Development

* Actively seek volunteers to help develop and staff Xeriscape activities and programs.
* Establish volunteer training in telephone procedures, fund raising, communications, meeting the public, programming, answering questions, etc.
* If demonstration gardens are available, develop a docent program and offer tours, classes, and workshops to the community.

Demonstration/Research

* Develop Xeriscape demonstration gardens in cooperation with arboreta, museums, businesses and corporations, city parks, schools, colleges, universities, and private citizens.
* Hold "X-rated," Xeriscape, garden parties.
* Organize tours around the community to view private, public, and corporate xeriscapes.
* When funds allow, support research efforts by water purveyors, universities, and arboreta.
* Organize volunteers to help collect and analyze research data, monitor the equipment, and publish the results.

Community Water Management

Xeriscape landscaping, when followed, will conserve water, reduce maintenance costs, and establish beautiful, environmentally sound landscapes, parks, recreational facilities, and greenspaces throughout a community. Conserving water averts the need to construct costly new delivery systems and waste treatment plants that would otherwise be needed to meet periods of peak loading. Xeriscaping also leads to changes in attitudes about water quality, water use, and how a community's water should be managed, especially in landscape irrigation.

Laws, Regulations, Ordinances

Everyone recognizes the need to regulate water — its harvesting, distribution, use, and cleanup. However, people often may resent the related laws/regulations/ordinances for one or more of the following reasons: the laws are subject to interpretation; the regulations are enforced with varying degrees of strictness; they are imposed upon by one more layer of governmental bureaucracy; they are required to petition for a variance if design or construction circumstances are unique and do not meet specifications. Unexpected drought or rapid growth increases demand for water and spurs legislatures and city councils to hasty action, often responding to the situation by passing short-sighted laws and ordinances accompanied by a battery of penalties for noncompliance. These quick-fix programs create conflict and erode confidence.

Water Conservation Incentive Programs

Xeriscape programming not only heightens the level of community awareness and understanding, but it also provides a forum for community consensus and conflict resolution. Water purveyors, planning departments, developers, representatives of the green industry, and community leaders can work together to develop incentive programs that conserve water rather than regulate its use by enforcement and fines levied in the heat of a water crisis. It's more productive in the long run to reward developers, contractors, businesses, homeowners — everyone willing to incorporate Xeriscape principles in landscapes and to continually apply sound water conservation techniques in managing them. Imposing regulations to control water use and levying fines for noncompliance is often counter productive and breeds resentment. Rather, it may be better to waive or reduce hookup fees and permit charges for those who Xeriscape. The reductions would be based upon cost savings to the water company for delay or elimination of a costly construction project to meet peak loading. Such a program would provide a positive economic incentive to the builder as well as the community.

Use cash prizes and community awards to promote and reward water-efficient designs and landscape conversions that significantly reduce water use. Change codes that waste water to specifications that encourage using efficient irrigation systems, selecting water-conserving plants, and planning with water conservation in mind.

Xeriscape and Urban Forestry

Xeriscape, What's the Urban Forester's role?

Water shortages hit the urban forest first. Water masters and governing bodies usually ask the public to be conscious of their water use and ask everyone to conserve water voluntarily when shortages occur. As the water supply diminishes, managers are usually forced to restrict or discontinue irrigating city parks, golf courses, athletic fields, and landscapes. If xeriscape principles have been employed, the impact of such an action may be minimal; otherwise the city may sustain considerable damage to trees, shrubs, and turf, especially if the ban is prolonged. Tree maintenance and removal costs will increase accordingly. Next, businesses and homeowners are asked to do the same. Lastly, after severe and prolonged drought, all outside watering is prohibited and traditional landscapes will be lost.

The urban forester should take an expanded role in promoting, supporting, and organizing Xeriscape programs in cooperation with the water purveyor and other interested agencies and parties. He or she should actively pursue changing city ordinances, building, and landscape codes to encourage water conservation. By reviewing landscape plans, plant selection, and planting techniques and verifying that the plans are carried out, the urban forester can do much to improve the status of the entire urban forest and beautify the city while efficiently using resources. Properly employed, xeriscape landscaping under the watchful eye of a good urban forester will serve as a hedge against drought and the increasing costs of maintaining the urban landscape.

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XI. URBAN SOILS

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URBAN SOILS

What Is a Soil?

Soil is a mixture of minerals, organic material, air and water. An ideal soil is about 50 percent solids — mineral and organic material. The organic portion consists of residues of plants (humus), animals and other living organisms. Numerous micro-organisms, nematodes, earthworms, insects, and many other living things inhabit the soil. Some are beneficial; others are not. Organic matter can vary from 0 to 90 percent, but in most urban soils, amounts of 3-8 percent are common. Unfortunately, city soils of the Interior Western States may contain less than 1/2 percent organic matter. Under optimum conditions for plant growth, about half of the pore space is filled with water, leaving the remainder of the pores filled with air. Without reasonable levels of both air and water, roots can not continue to grow; and if prolonged, trees die. This mixture of minerals, organic matter, both living and dead, water and air provide the environment for root growth.

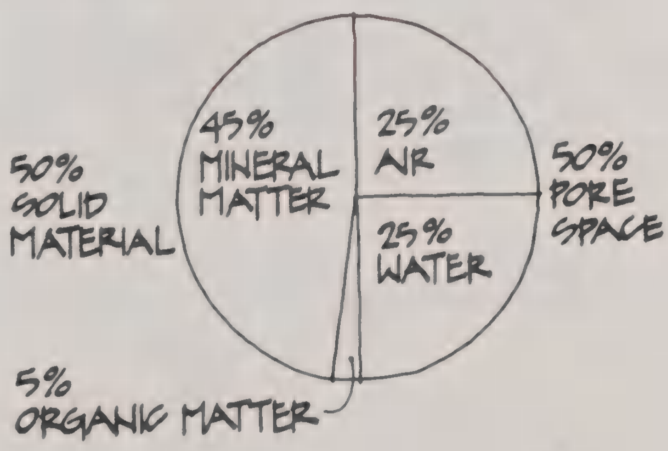

Figure 11-1. Composition of a Desirable Urban Surface Soil

Soils are very important in determining the kinds of plants that can be grown in an area and how well those plants will grow. There are 16 different nutrients that are essential for plant growth. Of these 16 nutrients, 13 are derived primarily from the soil. Soil also provides water storage and support for plant roots.

Soil Profile and Topography

If we cut a section down through the soil, we find several layers or horizons forming the soil profile (Figure 11-2).

The upper layer in native soils is the topsoil or "A" horizon. It contains more organic matter than lower horizons, more organisms and is usually more fertile and easily tilled than lower horizons.

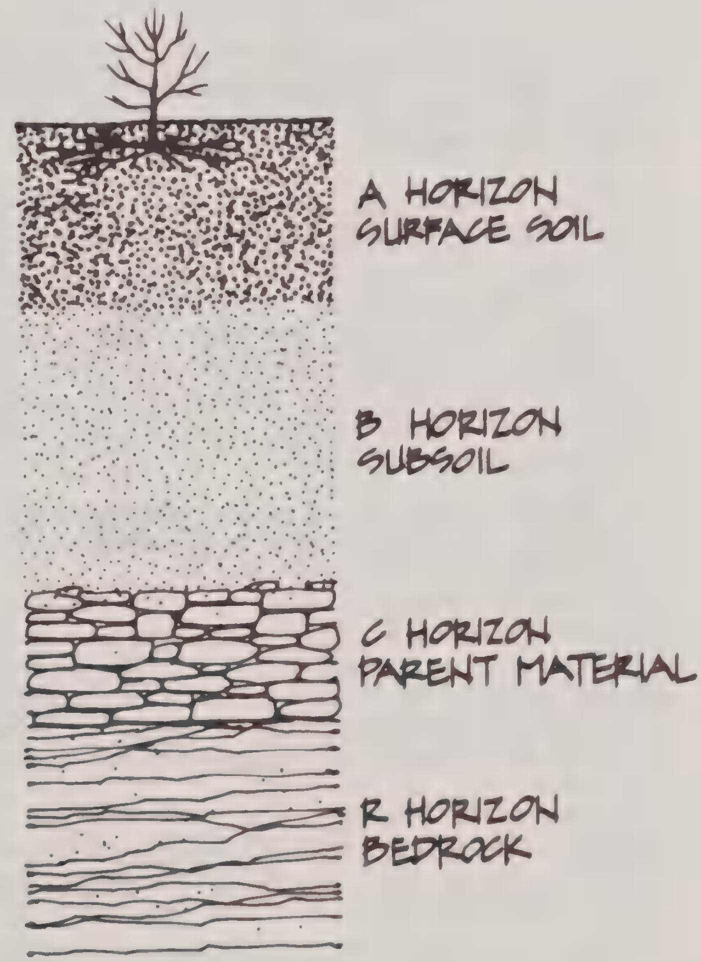

Figure 11-2. The Standard Soil Profile

Surface Soil — Zone of maximum organic matter accumulation, living organisms, porosity and leaching.

Subsoil — Zone of maximum accumulation of clay, iron, aluminum and lime. Lighter in color than surface soil. Few living organisms present below 3-5 feet.

Parent Material — Geological material such as loess or glacial till similiar to the original material from which A and B horizons developed.

Bedrock — Varies greatly in thickness and depth.

Below the topsoil is the "B" horizon or subsoil, which is generally lower in organic matter, especially living organisms, higher in clay and may contain more calcium carbonate and other salts. It also has a greater bulk density and fewer large pore spaces. This condition restricts air and water movement into and through the "B" horizon. Subsoil is less suitable for plant growth than top soil, especially if brought to the surface. And because it is low in organic matter, it crusts and compacts more easily.

The third profile layer is the "C" horizon or parent material. It is very similar to the original material from which the "A" and "B" horizons were formed. This horizon overlays bedrock.

These soil horizons vary in thickness, are not always easily discriminated and tend to blend into each other. Recently developed soils, such as many alluvial soils, may not have developed horizons. Urban soils have also often been disturbed by construction activities and given an addition of "top soil". The horizonation of urban soils, although badly mixed both vertically and horizontally, is still important.

The topography and lay of the land also helps us anticipate general soil conditions. Soils at the base or north of hills or in swales may be deeper, wetter and less stress prone for trees than soils on south-facing outcrops, which are generally thinner and drier. Soils of sedimentation, hills, alluvial deposits, eroded sites and low marshy sinks all have distinct characteristics that require different management schemes and adapted plants to be successful.

Some Easily Observable Properties of Soils

Anyone can learn a great deal about a soil by carefully observing four properties — color, texture, structure and depth. Each of these easily observable properties is closely correlated to one or more difficult to determine properties that actually control plant growth; therefore, we can infer the ability of a soil to support plants from these four properties.

Soil Color

Soil color has little direct effect on plant growth, but it is an indicator of soil properties that do affect plant development. The overall color of the soil is an indicator of organic matter content, drainage and aeration. Some soil color and characteristics associated with them are:

1. **Black**: High in organic matter, may be poorly drained. Soil becomes darker as organic matter increases from 0 to 8 percent. At 8 percent or above soil is essentially black.

2. **Brown**: Good organic matter content and well drained.

3. **Red**: Low in organic matter, well drained. Redness is due to oxidized iron.

4. **Gray**: Low in organic matter and poorly drained. Gray color is due to excess water and poor aeration.

5. **Yellow**: Low in organic matter and well drained.

Organic matter coats soil particles and masks their natural color. The natural color of soil particles is determined by their mineralogy. Since the abundance of many plant nutrients is also related to mineralogy, the unmasked color of soil particles becomes a key to potential nutrient availability. For example quartz is a common translucent mineral that contains no plant nutrients while feldspars, which are opaque white to pink or green minerals, are high in plant nutrients. In general the greater the diversity of colors among soil particles, the higher and more balanced is the potential nutrient-supplying power of the soil.

Soil Texture

Soil texture is determined by the relative percentage of sand, silt and clay sized particles that make up the mineral fraction of the soil.

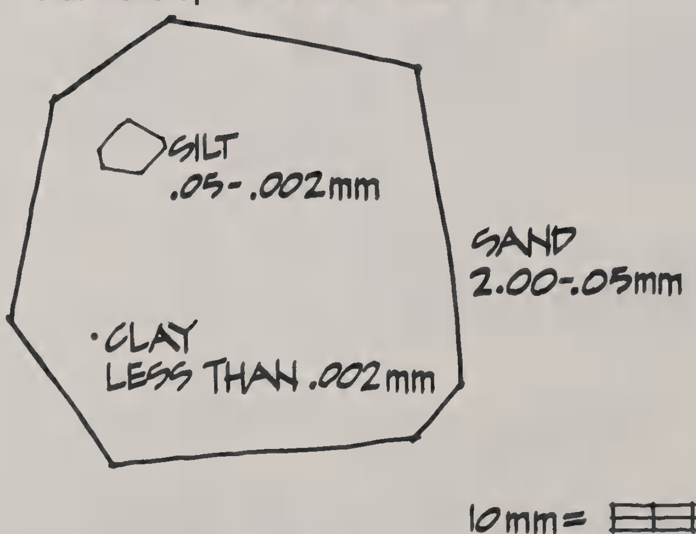

Figure 11-3. A Schematic Diagram Illustrating the Comparative Size of Sand, Silt and Clay Particles

Texture is a property that affects soil productivity by influencing water and air movement, ease of tillage, nutrient retention, and root growth. Most soils are made up of a mixture of particles ranging from relatively coarse particles that are readily visible to the naked eye to extremely small particles that can only be seen with powerful microscopes (Figure 11-3).

Some soils contain very coarse material such as gravel and even rocks, but for the most part soils are made up of mineral particles that fall into three size classes — sand, silt and clay:

1. **Sand**: When these comparatively large particles dominate, the soil is a coarse-textured or sandy soil. Sandy soils are frequently called light soils because they are easily worked. Sand particles contribute little to soil fertility and do not attract or hold much water; thus very sandy soils are usually droughty and infertile. However, a certain percentage of sand-sized particles can be desirable, contributing to better aeration, drainage and tilth. Quartz is the most common mineral composing sand particles.

2. **Silt**: Silt-sized particles are smaller than sand but approximately 25 times the diameter of clay particles and possess less than 5 percent of the surface area per volume of soil (Figure 11-3). They contribute little to soil fertility. Silt may be composed of quartz or the more chemically active minerals that compose the clay fraction.

3. **Clay**: These are very small particles that cannot be seen with the naked eye but exhibit a tremendous surface area per volume or weight of soil. Clay particles have about 1,000 times the surface area of an equal weight of sand. The surface of clay particles possesses negative electrical charges which are responsible for the ability of soil to retain certain nutrients in a form available to plants. Clay soils hold large amounts of water and drain slowly. High percentages of clay lead to fine-textured soils that are often termed "heavy" because they are more difficult to till and are easily compacted.

If we know the actual percentage of any two of these size fractions, we can determine the texture from a standard textural triangle (Figure 11-4).

Since we do not generally know these percentages without a soil test, we resort to feeling our way to an understanding of texture. If you can handle dry soil without getting your hands dusty then the soil is a sand. If the soil is coarse and sandy to the touch but leaves your hands dusty it is a loamy sand or sandy loam depending on how dirty you get. Dry soil that is not coarse to the touch, but that feels slick like talcum powder is a silt. Silt size particles fill the crevices in your finger print and make your fingers slide over each other smoothly. Wet soil that will allow you to form it into a "ribbon" by extruding it between your thumb and forefinger is either clay or clay loam. Wet soil that sticks together somewhat, but that refuses to form a "ribbon" without breaking into pieces is a loam or silt loam (Table 11-1).

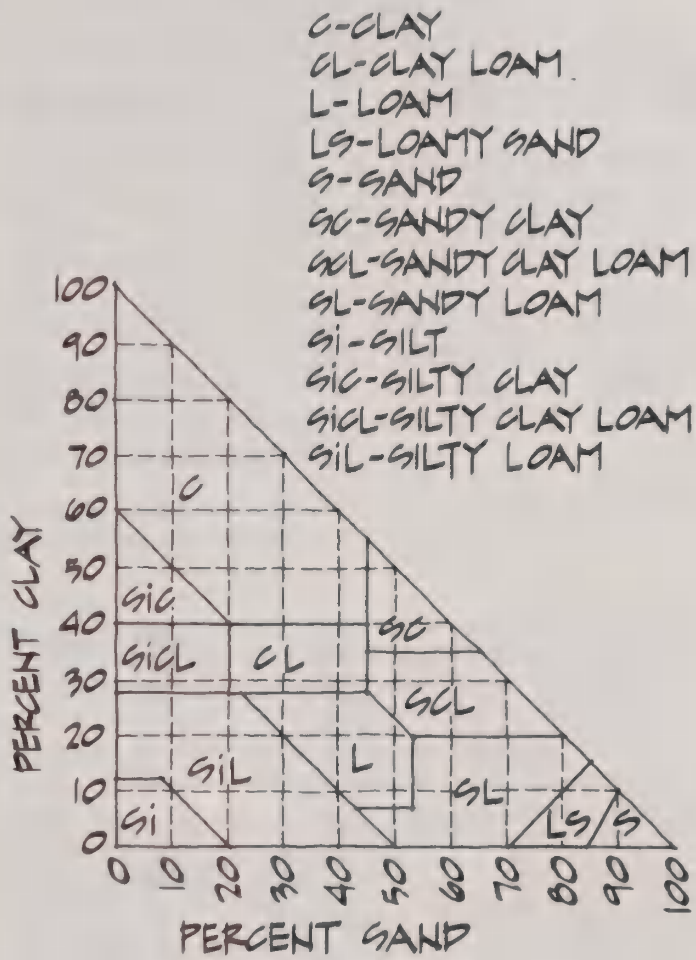

Figure 11-4. Soil Textural Triangle: Percentage of Clay and Sand In The Main Textural Classes of Soils: The Remainder in Each Class is Silt

One of the most important soil properties affected by soil texture is the ability to hold water against the force of gravity. Water is held in a film around soil particles. The attraction between water and clay-sized particles (adhesion) is so strong that plant roots have difficulty extracting water from the inner portion of the film. However, the outer portion of the water film is readily extracted by plants. When soil is holding the maximum amount of water it can retain against the force of gravity, it is said to be at its **field capacity**. When the water films have been reduced by evaporation or root absorption to the point that plants wilt and cannot recover even if irrigated, the moisture level is said to be at the **permanent wilting percentage (point)**. Water is still present (perhaps up to 25 percent of the soil's weight), but plants cannot pull it away from the soil particles fast enough to prevent wilting. The moisture content between field capacity and the permanent wilting percentage is the **plant-available water**.

Sandy soils hold less water than clays, but clays may not necessarily provide plants with a better supply of moisture. Very clayey soils are easily compacted and absorb water more slowly

Table 11-1. Soil Texture as Defined by Soil Textural Class and Estimated by Feel

Soil Textural Group	Soil Textural Class	Feel
Coarse to very coarse	Sand, Loamy sand	Feels gritty – does not ribbon or leave smear on hand.
Moderately coarse	Sandy loam	Feels gritty – leaves smear on hand, does not ribbon – breaks into small pieces.
Medium	Silt, Loam, Silt Loam	Feels smooth and flour-like, does not ribbon, breaks into pieces about 1/2 inch long or less.
Moderately fine	Sandy clay loam, Clay loam, Silty clay loam	Forms ribbon that breaks into pieces about 3/4 inch long. Sandy clay loam will feel gritty.
Fine	Sandy clay, Silty clay, Clay	Forms long, pliable ribbon more than 2 inches long. Sandy clay will feel gritty.

than sands. Thus, a sand may absorb and hold more moisture from an intense rain or irrigation than a clay where surface runoff loss is greater. Secondly, a higher percentage of the moisture attracted by clay is held too tightly for plants to extract it. The best soils for storing soil moisture are medium-textured silt loam soils containing adequate levels of organic matter. These allow rapid water penetration yet contain sufficient clay to hold water. Figure 11-5 illustrates how water-holding capacity is related to soil texture.

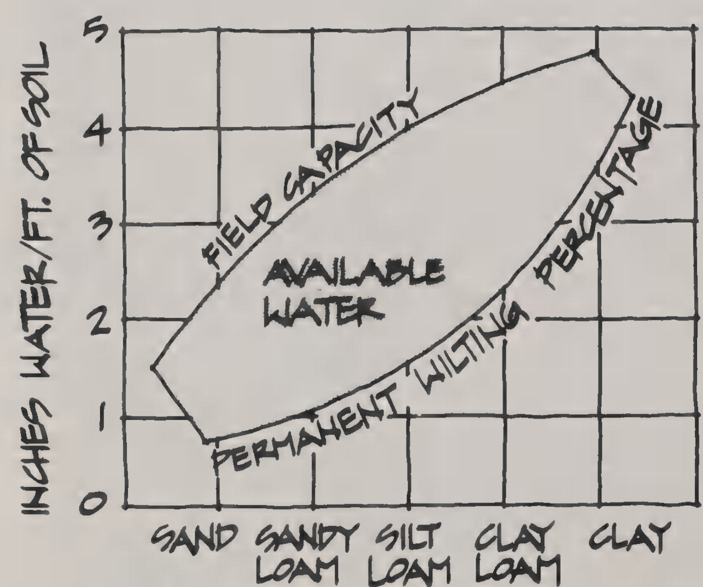

Figure 11-5. Water-Holding Capacity as Affected by Soil Texture

In a silt loam soil holding 3.5 inches of water per foot of depth, approximately 2 inches is available to plants. Sandy-textured soils may contain an inch or less of plant-available moisture per foot. A fine- to medium-textured soil can hold 8 to 12 inches of available moisture in the top 5 feet or nearly half the annual water requirement of many urban trees.

Sandy soils, although they hold little water, are able to supply abundant oxygen to plant roots (Fig 11-6). In clay soils on the other hand, low oxygen levels often limit root activity. Soils that are silt loam in texture not only have the most plant-available water, but also are well supplied with oxygen. By, and large, the world's great agricultural regions are dominated by silt loam soils. They perform well in cities where little supplemental irrigation is available for trees.

Soil texture can be modified by adding sand or clay or manufactured products such as "perlite" or "krum," but this is a monumental job. The upper foot of soil on an average house lot weights 400 tons. To convert an average size lot from a clay soil to a sandy clay loam soil would require the removal of 120 tons of soil, and replacement with 120 tons of sand and this mixed thoroughly to a depth of one foot. After all this effort, the second foot of soil would still be a problem! Needless to say, soil texture is seldom manipulated except on golf greens. We can, however, modify some of the properties imparted to a soil by its texture by altering its structure.

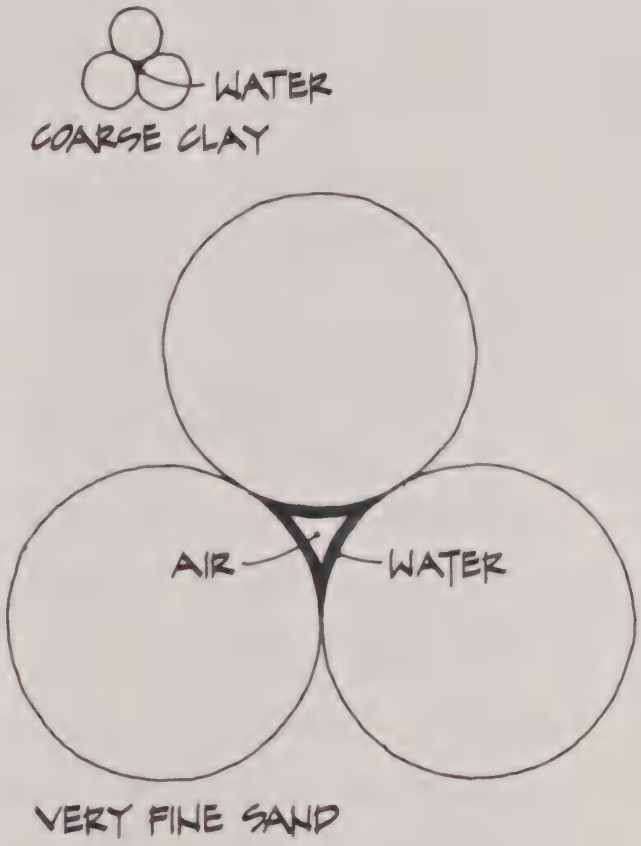

Figure 11-6. Approximate Proportions of Water Film and Air Held by Sand- and Clay-sized Particles at Field Capacity

Soil Structure

Soil structure is determined by the degree to which the soil's primary particles (sand, silt and clay), are bound together to form aggregates. The aggregation of soil particles creates structure. Some of the forces that cause aggregation are cohesive (attraction of like molecules for like molecules). Silt- and/or clay-sized particles may cling together due to their own electrostatic forces. But most aggregates are held together by adhesive forces, that is the particles adhere to one another because of organic, colloidal, or metal oxide coatings. The most common adhesive agent is mucilage from organic matter.

As organic coatings build up in a sandy soil, the structure proceeds from single grain through crumb and granular stages to a weak, subangular blocky state. During this process many of the large pores in the soil are filled with coatings and small pores are produced. This has the effect of increasing the soil's water holding capacity. As organic matter is added to a clay soil, the structure changes from massive to coarse blocky and finally to fine subangular blocky. As this occurs the fracture planes between the blocks produce more and more large pores. This increases both the water and oxygen supplying power of the soil. So we see that as structure develops, the ability of a soil to support plant growth improves, regardless of the soil's texture.

Clearly if we wish to alter the aeration or water regime of a soil, it is better to work on structure than texture. Adding organic matter in the form of peat moss, sewage sludge, wood chips, or manure can lead to a structural change. This in turn will alter the air and water regime of the soil. For the average residential lot, an annual addition of 1.2 tons of organic matter to the soil will achieve the same effect as replacing 120 tons of soil with sand.

Soil Depth (Volume)

The fourth easily observable soil property that serves as a key to a site's ability to support plant growth is soil depth. This might more properly be called volume. It is important to plants, particularly perennials, how much soil is available for their roots to exploit. An organically rich silt loam soil may hold abundant water and nutrients, but if there are only a few inches of it over solid rock, trees will not prosper. However, the soil does not have to be extremely deep. The majority of most tree roots in urban plantings are found within the top 3 to 5 feet of soil where oxygen and moisture are most abundantly available. In the urban setting, lateral extent as well as depth is important. Tree plantings where roots of several trees share the same soil volume in an island are much more successful from the tree's standpoint than single soil pits surrounded by concrete. If a planting site is bounded by streets, walks, or buildings the soil volume available for rooting may be quite small. Restricted root systems produce small trees susceptible to environmental stresses, especially when the canopy develops quickly in an unrestricted environment faster than the roots. Perry (1985) suggests that rapid growth to a predictable trunk caliper of 3" caliper trees is dependent upon, in part, the soil volume prepared at planting time.

Urban (1989) has discussed the critical need to increase soil volume in tree planting pits. (See Figure 8-6). Tree growth and ultimately tree decline are affected by numerous environmental parameters directly attributable to enlarged or restricted soil volume. Medium to large maturing trees require an expansive rooting volume to grow rapidly and avoid nutritional and drought stresses which lead to poor growth, insect and disease attack and chronic decline over several years and even, acute decline and death over days or weeks with severe, abnormal drought, winds or other adverse weather (Figure 11-7).

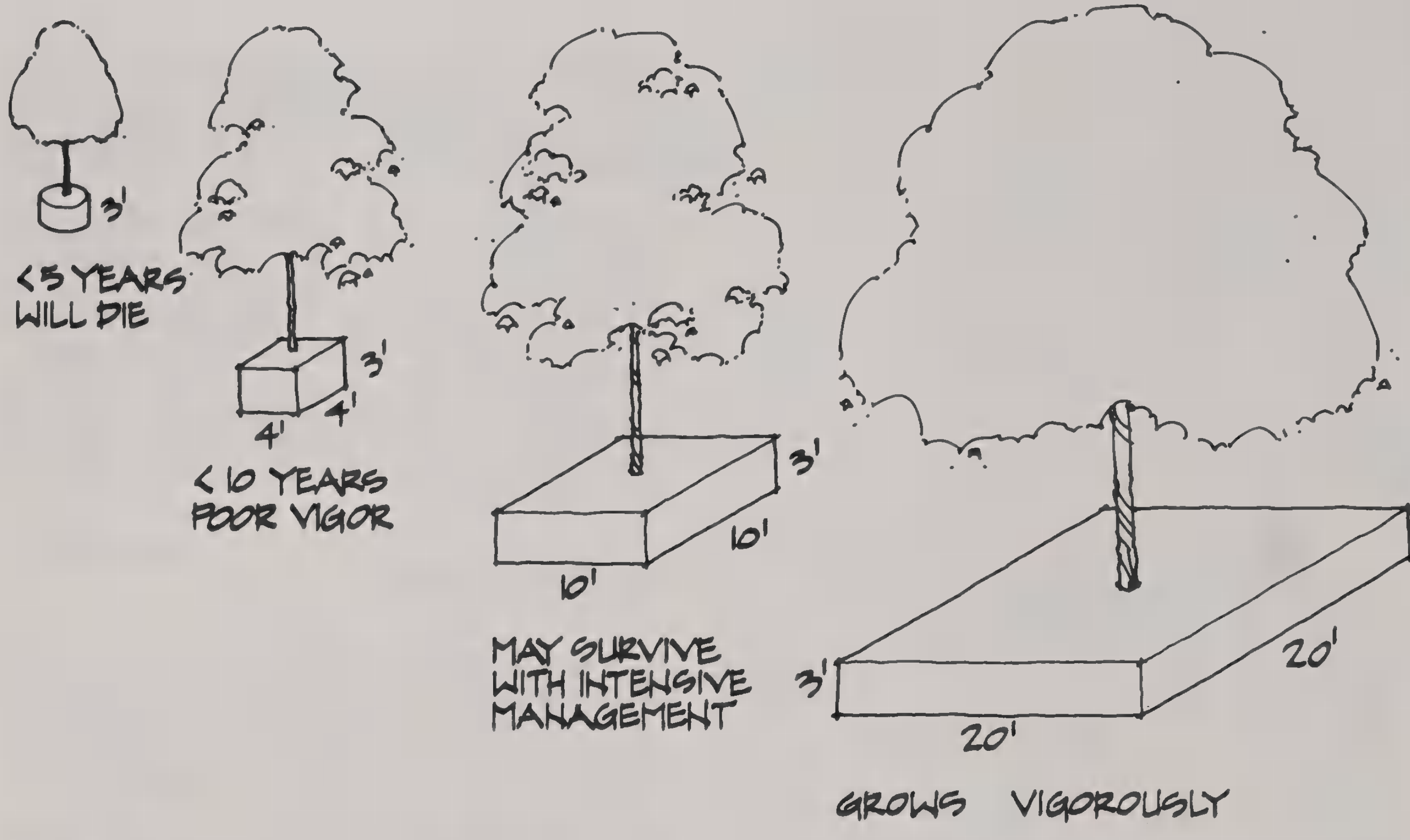

Figure 11-7. Future tree vigor is dependent on soil volume. In application, one foot of radial root space per inch trunk diameter is needed.

Table 11-2. Potential Risk to Tree Vigor For Different Planting Pit Volumes With 36" Depth.

	Planting Pit Volumes (cu. ft.)					
	30" Diameter (21)	4' x 9' (48)	5' x 5' (75)	10' x 10' (300)	15' x 15' (675)	20' x 20' (1200)
Potential Risk						
tree stress	very high	very high	very high	moderate	low	low
pest attack	very high	very high	very high	moderate	low	low
decline	<5 yrs.	<10 yrs	<15 yrs	may survive	survive	survive well

Soil volume, texture, and structure must be such that the soil can hold and make available essential elements required for vigorous growth. Soils must also provide adequate water holding capacity to buffer against periodic drought. More critically, soils must contain large pore spaces throughout to insure excellent drainage and oxygen diffusion to the roots. A coarse sand which has large pores would not supply the necessary nutritional re-quirements nor be able to hold enough water to avoid stress. On the other hand, a silt or clay soil would supply nutrients abundantly, but hold too much water, become water-logged and provide poor infiltration and drainage.

Another determinant of rooting volume is the presence of boundaries between materials of different texture. Although these boundaries between clay and sand, for example, occur in natural soils, they are much more common in urban soils where filling of depressions, digging basements and footings, trenching, etc. and the addition of "top soil" are common practices which disturb soil profiles and uniformity. Soils are often mixed and layered both vertically and horizontally, compounding many physical-chemical-root relations (Figure 11-8). Since fine-textured soil holds water more tightly than coarse-textured soil, a fine-textured layer must become saturated before it will give up water to a coarser layer. Also, coarse-

textured soil tends to lose water to adjacent fine-textured soil. Largely because of these moisture relations, plant roots often encounter boundaries between soils of vastly different textures as barriers. Thus, a tree "balled" in fine-textured soil and planted into a coarse-textured soil may sense the walls of the planting hole as a "pot" and develop a restricted root system. Likewise, a coarse-textured canning medium placed in a fine textured soil creates problems for root growth.

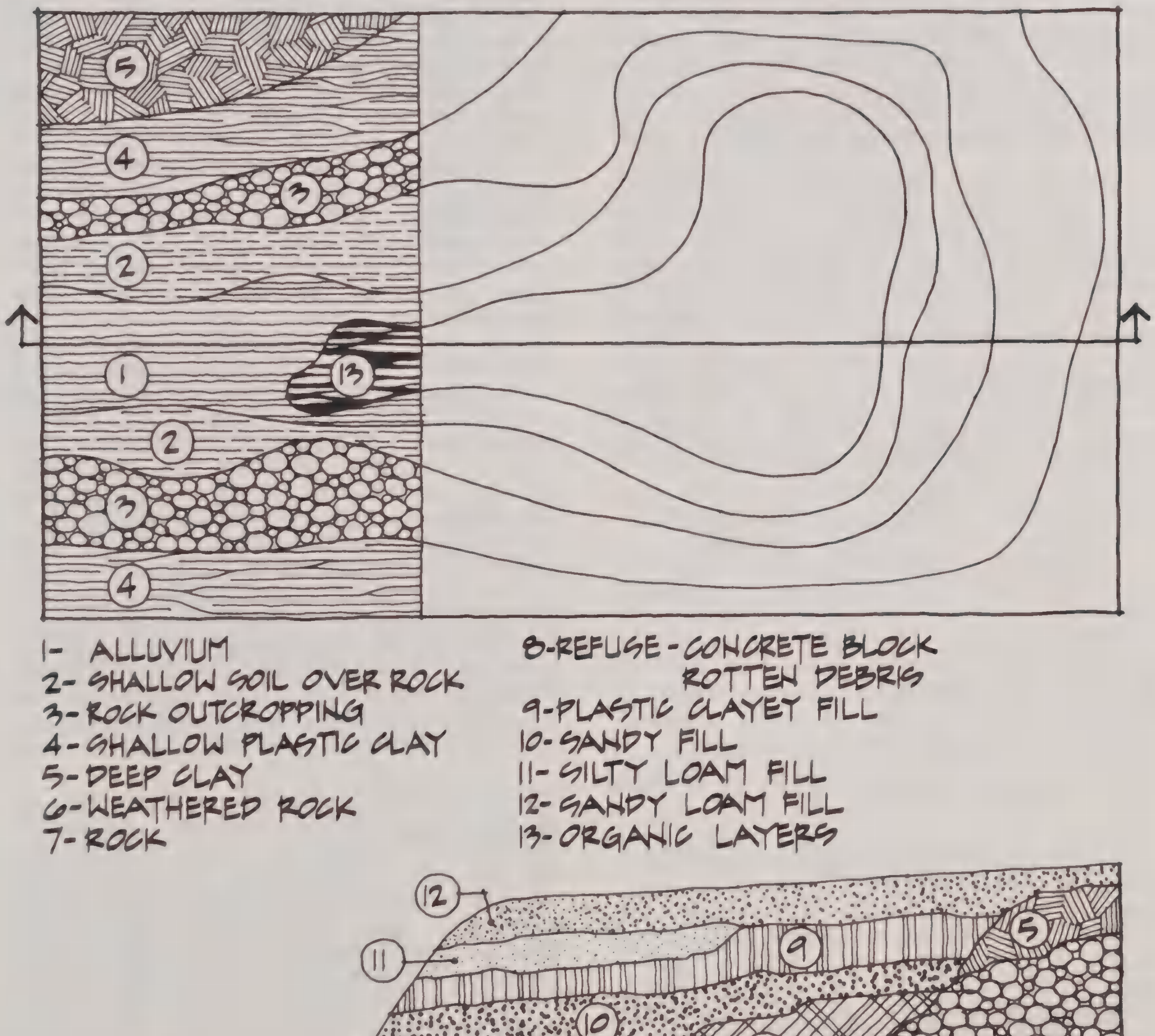

Figure 11-8. Vertically and Horizontally Mixed Urban Soil Profile of a Planting Pit

Not only do textural differences create boundaries for roots, so does power equipment. Moist soils, especially those containing considerable clay and silt, dug with a back hoe are glazed by the bucket as it makes the hole. If this glazed surface is not roughed up, say with a shovel, it will create an interface between the potting media and the natural soil. This interface will impede movement of water and air and may make it difficult for roots to grow into the existing soil. It may direct them in a circling pattern in the planting pit, creating a bound root system.

Soil layers may form within the soil horizons and impede the percolation or downward movement of water. Plow pans, natural pans, and caliche layers are common in western city soils. Likewise, abrupt changes or layers with distinctly different soil textures, e.g. clay over or between sands, slow water movement. In both cases water accumulates as a perched water table above the layer. Layering that creates perched water tables must be removed or tree roots will die for lack of oxygen or be attacked by root rot organism common to wet sites. Deep tillage to break up the layer may successfully eliminate the perched water table. If not, a drainage system will be required.

A water table to within 5 or 6 feet of the soil's surface can also restrict root growth, particularly if it fluctuates seasonally to an even shallower depth. Eliminating the source of the ground water by diverting it away, pumping ground water to lower the level and installing drains to maintain an acceptable level are the corrective measures available. All are expensive.

Soil Organic Matter

The most important manageable soil property is organic matter content. As we have seen, organic matter is important in promoting good soil structure. It is important in improving soil porosity, water holding capacity, bulk density, micro-organism populations and managing micronutrient imbalances as will be discussed later. Organic matter is also the major supplier of nitrogen (N) and phosphorus (P) in the soil. These two essential nutrients are demanded by plants in large amounts. As well, organic matter increases the cation ion exchange capacity of the soil, which helps retain other plant nutrients in the soil. It may also be used to modify soil pH and buffer the soil system.

Soil organic matter is derived from decomposing plant and animal remains. Although organic material may reside in the soil for several years it will ultimately be decomposed. Thus, the soil requires a constant addition of organic material in order to maintain its organic matter content.

Roots and soil organisms that die each year are a major source of organic material for the soil, but a large portion of the material required to maintain organic matter levels must come from above ground plant production. The removal of leaves, litter, grass clippings and other organic material from urban soils causes many such soils to have low organic matter content. Biannual or even annual dethatching of a lawn is preferable in terms of maintaining good soil conditions to regular collection of grass clippings.

Soil organic matter can be raised by the addition of peat moss, bark, manures, and many other organics, but this requires tillage. If tillage is not possible, organic matter levels can be maintained or ameliorated by the application of animal manures, sewage sludge, or highly composted green manure to the soil surface. The practice of mulching about the base of trees with bark, slash and other organic materials is recommended, not only for the organic matter that is added to the soil, but because soil surfaces compact and crust less, weeds will be fewer and easier to pull, water infiltration and soil aeration may be improved and erosion will be reduced. The addition of organic matter not only makes a vital contribution to the structural stability of soil by minimizing the breakdown of structure but it aides in the re-formation of structure. There are many physical, chemical and even aesthetic benefits incurred with the use of organic materials in the landscape. Unfortunately, so called "organic nitrogen" fertilizers contribute nothing to soil organic matter levels. Only the addition of organic materials can do that.

Other Physical Properties of Urban Soil

Bulk density is a measure of the relative density of a soil including the pore space. Bulk density equals the weight of the soil divided by the volume of the soil, expressed as grams (g) per cubic centimeter (cc or cm^3), or internationally, megagrams (Mg) per cubic meter (m^3). The density of the individual soil particles, their weight per volume of soil, is a major component of bulk density. Particle density depends upon the minerals contained in the soils with an average being 2.65 Mg/m^3. A good bulk density for a productive soil would be 1.33 Mg/m^3. About 50 percent of the volume would be pore space. Top soils should have a similar bulk density or less. The bulk density of subsoils is greater due to compaction and poor structure, usually 1.6 Mg/m^3 or more. Root penetration of soils is impaired at 1.7 Mg/m^3. A clay soil may have a bulk density of 1.05 to 1.10 Mg/m^3, but if aggregated well, the bulk density will be 1.00 Mg/m^3. The first may, however, hold too much water to grow plants well,

whereas the clay with good structure may be an excellent soil for plant growth.

Pore space is the second component important in understanding bulk density and its influence on soil characteristics important for tree growth. If soils have nearly the same particle density, then **porosity** (total pore space) accounts for the differences in bulk density. Sands have larger pores, greater **aeration** porosity, compared to clays; but the **total** pore volume per unit of clay soil is greater. Pores in clay are smaller, but there are significantly more of them. Aggregation of clays and silts increases aeration porosity in heavy soils. The large pores increase water infiltration and percolation, as well as air movement in soils. They are most prevalent in the "A" horizon. Small pores hold water, account for capillary water movement and the water made available to plants, but because they fill with air only as the soil becomes extremely dry they limit soil aeration. Large pores are necessary for drainage as well. There must be a balance in small and large pore space for proper root growth and to avoid root rot diseases.

The bottom line? Urban soils have increased bulk densities because little organic matter accumulates in the landscape and many of man's activities compact existing soils. As bulk density increases, soil permeability, air exchange and root penetration decrease. Soil compacting activities must be avoided at all times, and management that improves soil structure must be practiced to reduce the adverse effects of increased bulk density on plant growth.

Soil crusting increases in urban soils. Fine-textured subsoils are brought to the surface, less organic matter accumulates at the soil surface, bare soil is pounded by raindrops and irrigation, and pollutants, including petroleum-based aerosols, bind surface particles and, most importantly, foot and wheel traffic occur regularly. Crusted soils do not wet easily and are subject to erosion. Of greatest consequence, however, the soil profile beneath crusted layers becomes extremely dry and trees suffer drought stress – a major problem in urban plantings!

Develop designs to eliminate wheel and foot traffic over the root system of plantings. Use ground covers and mulches to lessen environmental impacts and at the same time contribute organic matter to soils prone to crusting. Change sprinkler heads to bubblers or soakers and use drip irrigation whenever possible. All these techniques and others reduce crusting. Figure 11-9 and Figure 11-10 summarizes many of the physical factors of soils that affect tree growth.

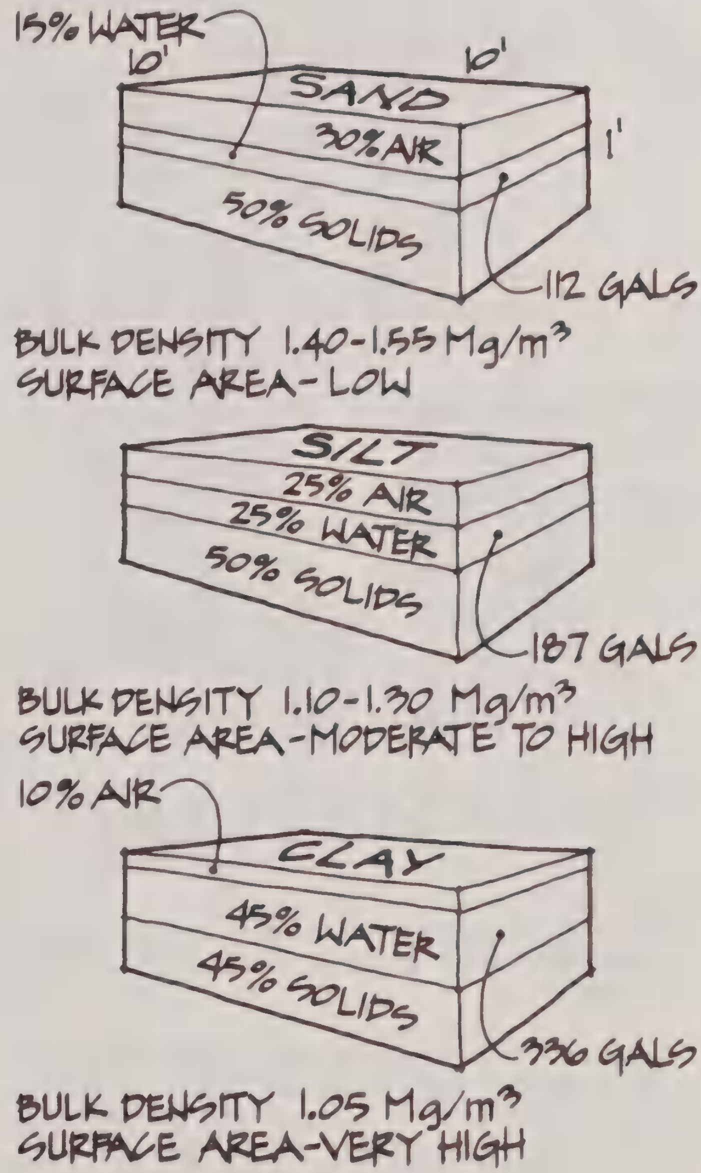

Figure 11-9. Water Holding Capacity, Aeration Porosity and Percent Solids of Three Soils (100 cubic feet) at Field Capacity

Urban soils have modified, often stressful temperature regimes. Shoots and buds of trees become acclimatized to seasonal variations. Short days and cooler temperatures of fall initiate dormancy in stems. Dormant shoots tolerate extremely cold temperatures. Roots do not go dormant and are subject to low temperature damage and death when soil temperatures go below the acceptable levels for the root's survival. In a natural environment, snow and accumulated organic matter insulate the roots from extremely low temperatures. Roots of urban plantings are exposed to harsher conditions and many shallow roots are damaged by cold, especially during winter when shallow roots may freeze and thaw on a daily basis.

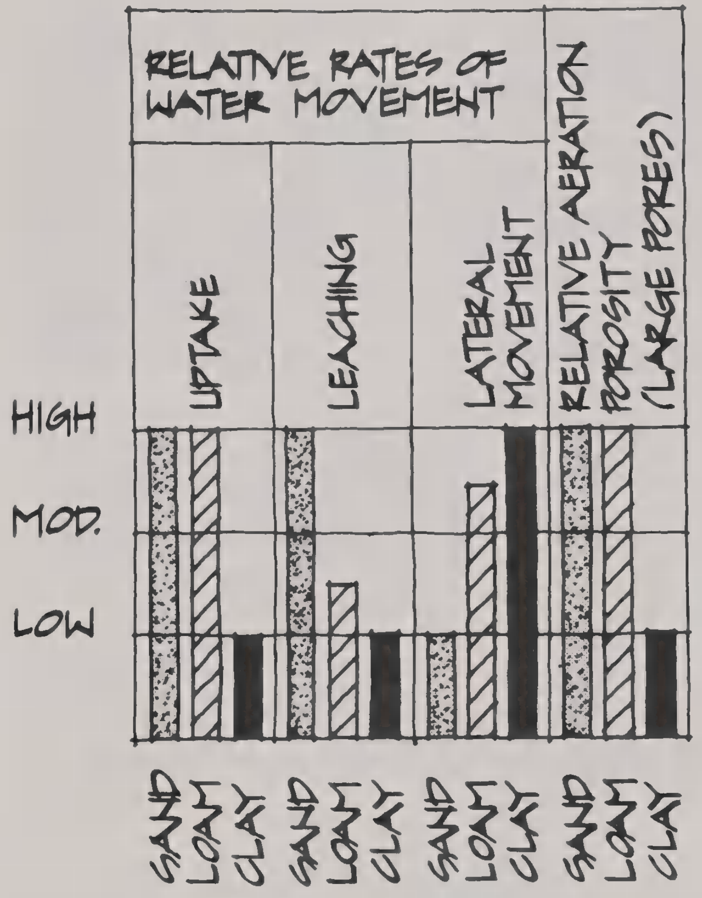

Figure 11-10. Relative Rate of Water Movement and Aeration Porosity of Three Soils at Field Capacity

High soil temperatures are prevalent in urban soils especially when trees are grown in above-ground planter boxes. Because tree canopies are discontinuous and soils are covered with little organic matter, heat loading of city soils is common. Concrete, asphalt and metal construction materials absorb, accumulate and re-radiate large amounts of heat. Shading and watering roots will reduce high temperature damage. Mulch roots and insulate planter boxes to stop damage from extreme low and high as well as fluctuating soil temperatures.

In developing subdivisions, home sites, shopping malls, industrial parks, streets, parks, and other large expanses, the first step taken is to "clear the land." Cutting, filling, terracing, leveling and smoothing the landscape follows; all accomplished with thought of quickly and efficiently erecting buildings and providing roads, utilities and all manner of services. This soil disturbance is often unnecessary and damages soils for satisfactory plant growth, almost irreversibly. In many cases, part or all of the razed land sits idle several months to years before construction activity actually begins. In the desert west this leads to catastrophe. With little available moisture, bare soils do not revegetate and wind erosion removes shallow top soil and dust hazards develop. Recently, two different developers in western Nevada were held responsible in class action suits for damage to adjacent subdivision property and impaired health of persons living next to cleared land standing ready for development. Both were costly for the developers. One award was for several million dollars.

Many soil-related problems inflicted upon city trees begins with poor or no planning to preserve soil integrity and structure. Loss of soil profile (structure, porosity, moisture conductivity, etc.) is often accomplished with **one** pass of heavy equipment, particularly if the soil is wet. Likewise, the price paid for litigation and awards by courts makes proper planning and soil protection during construction cost effective.

Urban Soil Fertility and Chemical Properties

Essential Elements

There are more than 100 chemical elements in nature but only 16 are considered essential for plant growth. If any one of these 16 elements is lacking, plants cannot grow to complete their vegetative or reproductive cycles. Some of these nutrients combine to form compounds which compose cells, enzymes, etc. Others must be present in order for certain plant chemical processes to occur.

Photosynthesis is one of the world's most important chemical reactions. Plants utilizing the sun's energy convert water and carbon dioxide into sugars and ultimately to plant growth. The principle nutrients involved in this process are carbon, oxygen and hydrogen. These three nutrients are derived largely from air and water. The 13 remaining essential plant nutrients required for plant growth are derived principally from the soil. These mineral nutrients are classified as primary, secondary or micronutrients according to the quantity required by plants. Primary nutrients are used in the largest quantities and are usually the first to become deficient in the soil. Micronutrients, also known as trace or minor elements, are required in very small amounts and are less frequently deficient. Even though nutrients are used in different amounts, each of the 16 is equally important for plant growth. The 16 essential plant nutrients are listed in Figure 11-11.

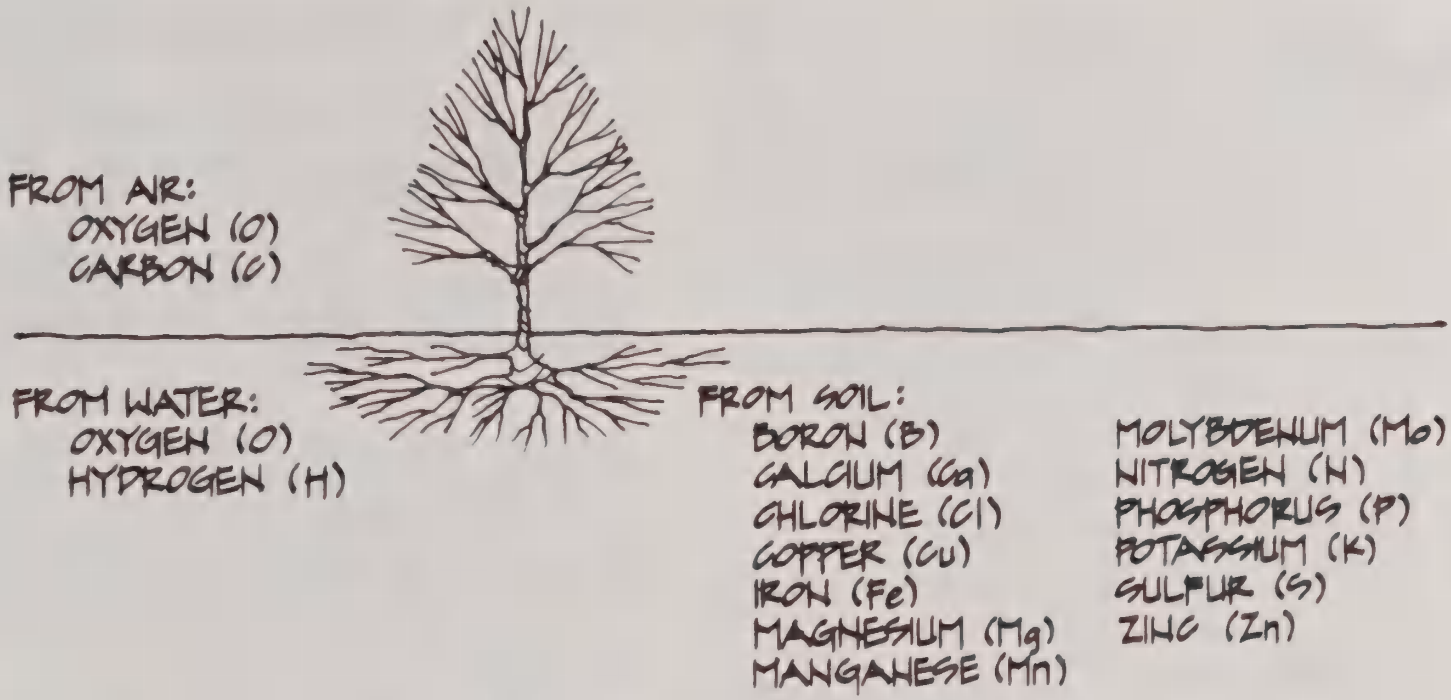

Figure 11-11. The Essential Plant Nutrients Derived From Air, Water, and Soil

During soil formation, minerals are broken down into microscopic clay particles. The smallest of these clay particles, along with soil organic matter, are called **soil colloids**. Colloids possess tremendous surface area and make up the chemically active portion of the soil. Clay colloids are plate-like in structure and are composed of mica-like layers that could be compared to miniature slices of bread.

Each colloid has a net negative electrical charge that developed during its formation. These charges attract and hold opposite (positive) charges much as unlike poles of a magnet attract each other. Similarly, the negatively-charged colloids repel negatively charged particles as the poles of a magnet repel each other. The ability of soils to attract and hold positively charged nutrients is one of the most important soil properties involved in soil fertility and plant nutrition.

Ion Exchange and Plant Nutrition

All chemical elements including nutrients can exist in nature in an electrically charged state. When an element carries an electrical charge, it is called an ion. Nutrients are absorbed by plant roots as ions and are either attracted to or repelled by soil particles. Ions may carry either a positive or negative electrical charge. Ions with positive charges are called **cations** while those with negative charges are **anions**.

Table 11-3: A Partial List of Common Soil Cations and Anions, in the Forms in Which They are Absorbed by Roots

Cation in Soil		Anions in Soil	
NUTRIENTS			
K^+	Potassium	NO_3	Nitrate
NH_4^+	Ammonium	SO_4^{-2}	Sulfate
Mg^{+2}	Magnesium	H_2PO_4	Phosphate
Ca^{+2}	Calcium	Cl^-	Chloride
Mn^{+2}	Manganese	BO_3^{-2}	Borate
Zn^{+2}	Zinc	MoO_3^{-2}	Molybdate
NON-NUTRIENTS			
Na^+	Sodium	OH^-	Hydroxyl
H^+	Hydrogen	HCO_3	Bicarbonate
$A1^{+3}$	Aluminum		

Many chemical compounds, including fertilizers, are combinations of these cations and ions. For example, the calcium ion Ca^{++} can combine with the sulfate ion $SO4^=$ to form calcium sulfate (gypsum), CaSO4, with phosphate ($HPO4^=$) to form di-calcium phosphate (CaHPO4) or with carbonate ($CO3^=$) to form calcium carbonate (lime), CaCO3.

The attraction of unlike charges enables negatively charged soil particles to attract and hold cations. Cations are held on the soil colloids (clay and humus) rather tightly, yet not permanently in a form that resists removal by leaching. But through an exchange process these cations may be released into soil solution where they can be absorbed by plant roots. One cation can

exchange for another on the surface of the colloids; thus, the negative charges on the colloid are called exchange sites. Figure 11-12 is an illustration of how cations are held by soil colloids and how they exchange between the colloid, soil solution and roots. Note that anions are not held by the colloid. Consequently, they are easily leached through the soil profile.

Figure 11-12. A Schematic View of Cation Exchange and Root Absorption

Cation Exchange Capacity. Cation exchange capacity (**CEC**) is a measure of the amount of cations a soil can hold in an exchangeable form. The higher the CEC, the more cations a soil can retain. The CEC is important because it affects the ability of the soil to supply the cations listed above for plant growth and the amount of lime required to correct soil acidity.

Cation exchange capacity is determined as part of a standard soil test and expressed on soil test reports in terms of milliequivalents per 100 grams of soil (meq/100g). Soils differ in their CEC depending on clay and organic matter content. The CEC of clay varies from 4 to 100 meq/100g Humus has an average CEC of 200 meq/100g . . . A rule of thumb for estimating CEC is:

CEC = % organic matter X 2 + % clay X 0.5

Thus, a soil with 3 percent organic matter and 20 percent clay would have a CEC value of 16 meq/100g.

Soil texture affects cation exchange capacity. The more clay, the higher the CEC. Some examples of CEC values for different soil textures are:

Soil	CEC meq/100g
Sands	2-3
Loams	10-15
Silt Loams	12-25
Clays & Clay Loams	20-50

Knowledge of a soil's CEC gives us some general ideas about several of its properties. Soil properties common to high and low CEC soils are listed below:

Soil with a CEC Range of 11-50 meq/100g

* High clay or humus content
* More lime required to correct a given pH
* Greater capacity to hold nutrients
* High water-holding capacity
* Lower porosity, if soil is inorganic
* Often crusts easily

Soil with a CEC Range of 1-10 meq/100g

* High sand content
* Less lime required to correct a given pH
* Nitrogen and potassium leaching more likely
* Low water-holding capacity
* Increased porosity, if soil is inorganic
* Generally does not crust

Some cations are held more tightly than others on exchange sites and are released into the soil water solution less easily than are others. Some common cations are listed below in order of the strength of bonding to the exchange sites.

	Cation	Bonding Strength
H^+	Hydrogen	Strongest
Al^{+++}	Aluminum	↑
Ca^{++}	Calcium	
Mg^{++}	Magnesium	
K^+	Potassium	
$NH4^+$	Ammonium	↓
Na^+	Sodium	Weakest

It is easier for hydrogen to replace a less tightly held cation such as potassium on an exchange site than vice versa. But even Na^+ can replace H^+. Relative concentrations of one nutrient to another also affect exchange. For example, potassium fertilizer increases the concentration of K^+ ions and consequently, increases the chance of

replacing a more tightly bonded cation at an exchange site by mass action.

There is an equilibrium balance between cations on the exchange complex and cations moving freely in the water solution. Though the concentration of cations in solution is very small at any one time, most cations are absorbed by plant roots from the solution phase. As nutrients are removed from solution by plant roots, the balance is upset and other cations come off the exchange sites into solution to maintain the correct chemical equilibrium. (See Figure 11-12).

Anion Retention In Soils. Since anions carry negative electrical charges, they are not retained by soil colloids. Anions such as nitrate ($NO3^-$), sulfate ($SO4^=$), and chloride (Cl^-) are very soluble and move with water. Sulfate can be loosely held by positive charges that develop on certain colloids under low pH conditions.

Phosphate ($HPO4^-$ and $H2PO4^=$) ions do not move freely in soils largely because they form relatively insoluble compounds with iron and aluminum in acid soils and calcium in high pH soils.

Fertilizers add cations and anions to the soil. As they dissolve in the soil solution, the ions are made available to plants and as replacements on exchange sites. Compounds in most inorganic fertilizers are readily dissolved into their ionic forms while organic compounds are more complex and require that microorganism break them down first, providing a slow release of the ions over time.

Soil Acidity (pH)

Soil acidity affects several soil chemical reactions that influence plant growth, nutrient availability and the effectiveness of fertilizers. We commonly measure soil acidity as pH.

The term **pH** defines the relative acidity or alkalinity of a substance. The pH can vary from a minimum value of zero to a maximum of 14. The midpoint of 7.0 is considered **neutral** while values below 7.0 are **acid** and values above 7.0 are **alkaline**. The pH of most productive soils ranges from about 4.5 to 9.0 as shown in Figure 11-13.

Soil acidity is caused by ions of hydrogen and aluminum, but for our purposes we will consider only hydrogen ions (H^+). The pH is a measure of the H^+ concentration. Hydrogen ions are a result of the separation of water molecules (H2O) into H^+ and OH^-. In acid soils, H^+ outnumber OH^- ions; in neutral soils, H^+ and OH^- exist in equal concentrations and in alkaline soils, OH^- ions predominate. The actual concentration of H^+ is very small and difficult to express in conventional

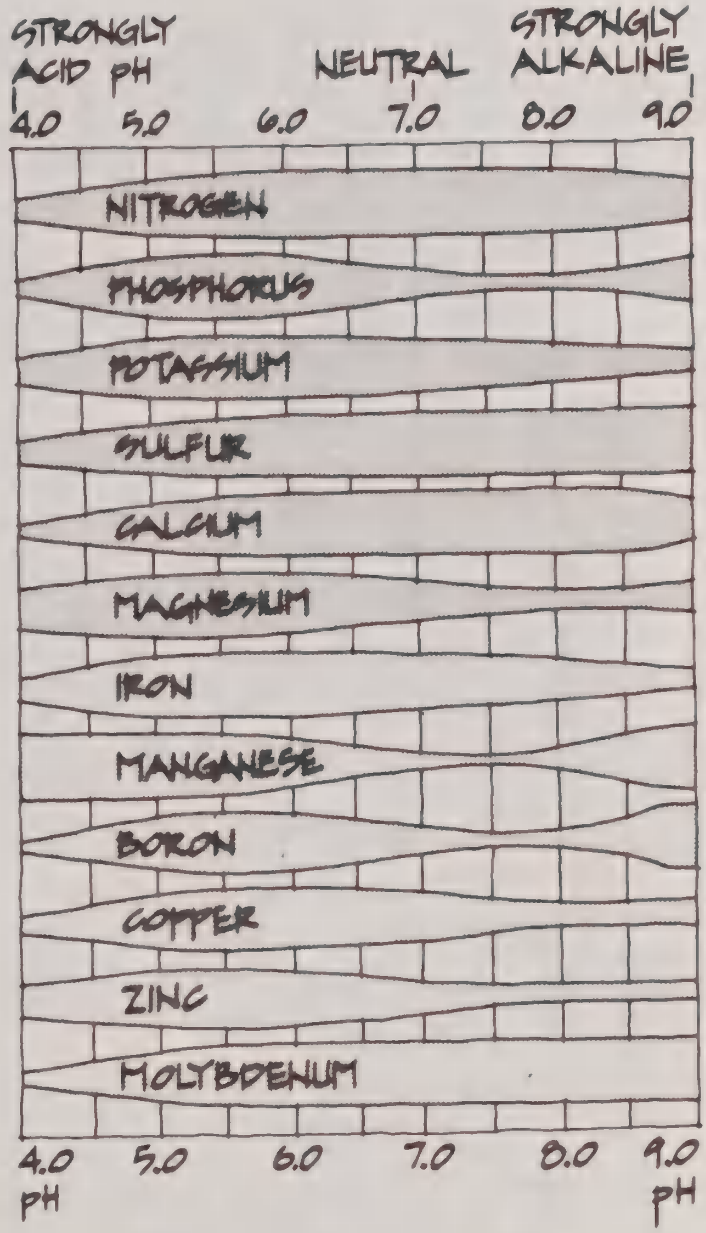

Figure 11-13. Effect of pH on Nutrient Availability in Organic Soils. Compare to Figure 11-14.

mathematical terms. For example, the H^+ concentration at neutrality is .0000001 or one ten millionth. A more convenient form of expressing the number is 1 X 10-7 or pH 7.0. The term pH is a mathematical notation for the negative logarithm of the hydrogen ion concentration. Because pH is a logarithmic expression, the pH scale is not linear. A change in one pH unit means the change in acidity (hydrogen ion concentration) is ten-fold. As you might guess, the H in pH stands for hydrogen.

The variation in soil pH from acid to alkaline is a result of several factors including:

1. Parent Material — Rocks from which parent material originally formed varied from acidic to alkaline in reaction.

2. Precipitation — The higher the average annual rainfall, the more leaching that occurred over time. Leaching removed alkaline elements such as Ca and Mg leaving acidic elements such as H, Mn and aluminum.

3. Native Vegetation — Soils formed under forests tend to be more acid than those developed under grassland. Conifers tend to cause greater acidity than deciduous forests.

4. Crop Grown — Removal of grass clipping and leaves removes nutrients such as Ca and Mg causing acidity to increase.

5. Nitrogen — Nitrogen from fertilizer, decomposing organic matter and manure or N fixation by bacteria in legume roots produce acidity. Each pound of N requires about 1/2 pound of lime to neutralize the acidity. Nitrogen does not usually cause rapid declines in soil pH, but over a period of time, the reduction can be significant. The rate of acidification is faster if N rates are higher than crop needs or if the soil's cation exchange capacity is low.

Soil acidity has several direct and indirect effects on plant growth and nutrition. These effects are summarized in Figure 11-14, compared to Figure 11-13 and in the list below:

1. If pH is too low, iron, aluminum and manganese dissolve in amounts that can be toxic to plants. These metallic elements also react with phosphorus to form phosphate compounds that are relatively unavailable to plant roots.

2. If the pH is too high, the availability of phosphorus decreases because high levels of calcium create relatively insoluble calcium phosphate compounds. The availability of several micronutrients is decreased in high pH soils. Potassium availability may be decreased if excess lime is present.

3. Soil pH affects the population and activity of micro-organisms. These organisms decompose organic matter releasing nitrogen, phosphorus, sulfur and several micronutrients., Aggregation of soils increases with increased micro-organism activity. Pathogenic micro-organisms that cause plant disease are pH sensitive and may proliferate at a specific pH.

4. The activity of symbiotic bacteria associated with legume nodules is impaired in acid soils, resulting in less N fixation by legumes.

5. In acid soils, there is less calcium and magnesium available for plants. Magnesium deficiencies can occur, but calcium deficiencies are very rare.

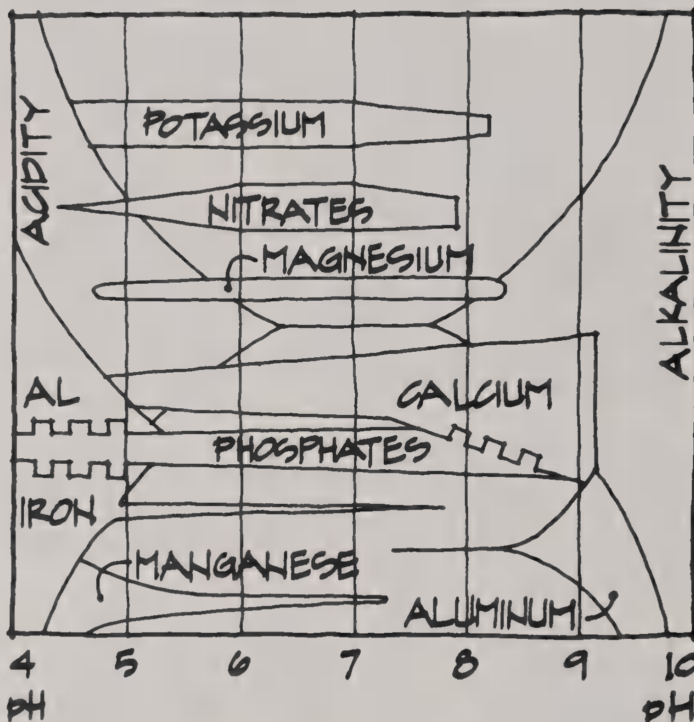

Figure 11-14. The Effect of pH on Nutrient Availability in Mineral Soils. Compare to Figure 11-13.

As one can see from Figure 11-12, a soil acidity of about pH 6.5 provides optimal nutrient availability. This is also a good pH for the growth of most plants. There are exceptions, and some common ornamental plants such as holly, magnolia, rhododendron, beech, and most conifers require higher soil acidity (lower pH). Soil acidity can be raised by the application of sulfur either as elemental sulfur or as a weak acid solution. In calcarious soils commonly found in the west, the incorporation of organic matter may or may not alter pH, but aggregation and drainage will be improved. The use of acid fertilizers may gradually increase acidity. Do not add gypsum to calcarious soils to reduce pH and improve aggregation. Doing so only adds more soluble Ca to the soil and makes it saltier. Soil acidity is commonly lowered by the addition of calcium carbonate (lime). The reactions that change soil acidity proceed slowly; therefore, up to a year may be required after application of sulfur or lime for soil pH to change appreciably.

A major and increasing problem is the leaching of excess plant nutrients that have been applied as

fertilizer in urban areas. Urban storm runoff is now a major non-point source of water pollution thanks to these leaching losses. In the future, we must be more precise in tending to urban soil fertility problems if we also wish to preserve general environmental quality. Regulations in fertilizer and pesticide inputs now appear to be the only way to address serious non-point source pollution problems from agricultural and urban lands.

We almost always over fertilize in the urban setting. Most lawns require about one pound of N per 1000 square feet per week. This works out to about 80-100 pounds of N per year for an average 3000 square foot lawn in an area with an 8 to 9 month growing season. Trees demand less. In general, more than this amount is produced naturally by decomposition, but many insist on adding a nearly equal amount as fertilizer. The need for P, K, in fact, most nutrients is much less than that for N, and natural processes usually supply adequate amounts.

This is not to say that N, P, K, Fe and other nutrients are not sometimes deficient, and that trees do not respond nicely to fertilization. However, the shotgun approach to fertilization is to be avoided. Spending a little time and money to find out what nutrients, if any, should be added will save money and reduce environmental pollution in the long run.

Salt-Affected Soils

Salt-affected soils contain a high concentration of soluble salts that cause plants to be relatively small, bluish-green and have leaves with brown, necrotic margins. New roots grow poorly, are short and larger in diameter, produce few root hairs and are dull tan or brown at their tips compared to normal, thin, shiny white roots. High salts can induce selected nutrient deficiencies and alter nutrient uptake in general. They may occur at any pH, but are common throughout the west as alkaline saline or sodic soils.

Salts absorb moisture due to their osmotic properties. A high concentration of salts in the soil binds water tighter than roots can absorb it. Salts actually draw water from the roots in the most severe cases, and plants become water stressed and dehydrated. Although sodium and chloride ions may accumulate to toxic levels for plants, the reduction in available soil moisture is most harmful to plants. If climatic conditions are mild, it may take several years for a tree to succumb, although growth will be weak. Plants under drought or heat stress may die rapidly. Fertilizers are forms of soluble salts. Over application or use on moderately salt-affected soils increases the potential for plant stress and damage.

Salt-affected soils include saline, sodic and saline-sodic conditions. A **saline** soil is characterized by a pH < 8.5, an EC > 4.0 mmhos/cm and an ESP (or SAR) < 15 percent. The electrical conductivity (**EC**) of an extract taken from a water-saturated soil paste estimates the salt content of the soil in mmhos/cm. EC increases with higher salt concentrations. The exchangeable sodium percentage (**ESP**) measures the extent to which the exchange sites within a soil are occupied by sodium (Na^+) relative to the total number of exchange sites. ESP is approximately equal to the **SAR** or sodium absorption ratio (the ratio of soluble sodium to soluble calcium + magnesium in the saturation-paste extract) measured in soil testing laboratories. Saline soils exhibit good structure and consequently may have good porosity and drainage potential. However, naturally salty soils exist because the site does not drain and salts accumulate through evaporation. Saline soils produce a white salt crust at their surface and were called "white alkali." Recently many soils have become saline because salt-laden irrigation waters have been applied without adequate drainage or ground waters within a region have risen with increased irrigation and become a source of soluble salts.

Saline soils are reclaimed by leaching the salts out of the profile. This implies that surface and subsurface drainage is available naturally or has been installed. Where water tables are high, they must be lowered before a reclamation program can be effective. Calcarious soils, common to arid regions, are improved by adding organic matter which helps aggregation and leaching. Do not add gypsum ($CaSO_4$) to calcium clay soils. Gypsum added to calcarious soils does not increase aggregation — it just adds calcium, which increases the salt hazard.

When the sodium content of a soil increases the pH increases and soils disperse or loose their ability to aggregate. This reduces porosity. With high sodium concentrations, these **sodic** soils become slick and when wet they swell appreciably and do not drain. Upon drying, sodic soils shrink, producing large soil cracks and hard clods. Sodium is directly toxic to plants; sodic soils are barren. Any organic matter in the soil accumulates at the surface as a black crust, therefore the old name "black alkali." Sodic soils generally have a pH of 8.5 or greater, an ESP (SAR) equal to or greater than 15 percent and an EC < 4 mmhos/cm.

Gypsum ($CaSO_4$) is used to reclaim sodic soils. Do not use lime! Because sodic soils are not structured, there are no large pores and sodic soils do not drain. When Ca^{++} ions from gypsum replace Na^+ ions on the soil colloids the soil aggregates — water movement and drainage is

restored. Soluble sodium salts formed following the exchange can then be leached from the soil. Sulfur, lime sulfur, iron sulfate and aluminum sulfate may also be used to reclaim sodic soils, **but only if lime ($CaCO_3$) is present in the soil!** Each of these products must be evaluated as to the time required and expense involved in the reclamation. The reclamation is not complete until the sodium is leached from the soil profile. This may require the installation of a drainage system.

Saline-sodic soils have a pH < 8.5, an ESP (SAR) equal to or greater than 15 percent and an EC greater than 4 mmhos/cm. Fortunately, these soils are aggregated and will leach. Add organic matter, gypsum and leach to improve their ability to support plant growth. Reclamation of salt-affected soils requires months to years, depending upon the volume of soil to be reclaimed, the products applied, their reaction time and the quality of the water used to leach the profile.

Soil Testing

Many of these properties of soil can only be determined by laboratory testing. Soil testing laboratories have traditionally been associated with Land Grant Agriculture Universities and their services made available through Cooperative Extension Agents or Specialists and researchers who also interpret the results and make recommendations. Today, commercial soil testing laboratories and professional consultants are also available. By following test-based recommendations in urban soil management and fertilizer programs, much can be done to improve soils for better plant growth, to conserve resources and to reduce non-point source pollution.

Urban soil sampling procedures are different from those used in general agriculture, even though many of the same evaluations are made. If landscape soils have not been disturbed and they appear uniform over the entire landscape (that is, plant growth and conditions are similar, and color, texture, structure and depth are the same), then a typical composite sample may be taken and analyzed. More often than not, urban landscapes require samples that represent individual and/or representative plantings as well as any obvious differences in soil patterns or properties. This includes taking samples at selected depths with differing characteristics. It is also important to sample any soils brought onto the landscape to improve existing sites or to be used as fill. Specific lab requirements and sampling procedures will be supplied by each laboratory.

Urban Soil Water Relations

Much of the Interior West is desert and subject to an arid climate with hot, stressful summers. City trees should be selected for their drought and soil tolerances. Even then and with few exceptions, trees in western cities require supplemental irrigation. Flood, basin, ditch and sprinkler systems have been common in the past. But with increased demands for water by agriculture, industry, recreational businesses and people for nonlandscape uses, more efficient schemes and systems have been devised, including conservations programs. Chapter X, Xeriscape, describes these.

Tree roots grow where adequate levels of moisture and oxygen exist in the soil and many city trees die because they receive too little or too much soil moisture. Since tree roots require oxygen for metabolic reactions and nutrient absorption and wet soils exclude oxygen, roots suffocate in wet sites. Without oxygen, roots and micro-organism respire anaerobically and produce root-toxic compounds as well as excessive heat. Roots weaken or die from invading diseases and insects. Prolonged drought desiccates roots. Opportunistic organisms may also infest drought-stressed root systems. Tree water stress is a major urban tree problem in western cities.

As is evident from this discussion, soil characteristics greatly affect the status of available soil moisture and ultimately the health of trees. Being able to recognize unfavorable soil properties for maintaining appropriate soil moisture levels, as well as knowing how to modify them is critical in urban tree management.

Texture, structure, porosity, organic matter content, water holding capacity, infiltration and percolation rates, the presence of salts, impervious layers, slopes, swales, depth to a water table, etc., all impact soil moisture availability. Plant water use is also influenced by seasonal climatic conditions and plant selection and must be integrated to properly schedule irrigation.

Naturally wet areas are usually low spots in the landscape. They may be filled wth soil, but they most often must be drained via surface ditches, perforated plastic pipe or tile bedded in gravel within the subsoil to eliminate water. To be effective drains must be installed into or below, never above, a water table. They must be in the zone of saturation and designed to drain to a lower area — leach field or dry well — where accumulated water can be removed by pumping. To effectively carry the water away, the system must have at least a slope of 0.1 foot per 100 feet.

We often create or recreate wet spots by building structures that impede drainage. Buildings, streets, walks, even sewer or water lines can form barriers to natural drainage and cause water to accumulate. In addition, excess irrigation water must drain to somewhere, and we seldom provide drainage from irrigation water in urban areas. Obviously the solution to excessive soil moisture is to know its cause and location. Then, one can make construction plans so as to avoid disturbing drainage patterns, or provide a new drainage system to replace the natural one.

Berm plantings of trees may be made in permanently wet sites where subsoil drainage is not possible or economical and trees would be desirable. Soluble salts are prevalent in such sites and care must be taken so that they do not move by capillarity into the mound and root zone of the berm. Several inches of coarse gravel covered with a porous, nondecomposing fiber above the wet soil will do. Then a mound of top soil several feet thick can be added above the layer and planted with trees and shrubs.

Irrigation is necessary in many urban areas in order to keep trees alive. This is especially true throughout the west where many towns are below the "tree line" — that is, at elevations where precipitation is inadequate to support tree growth. Of course, good quality water must be applied or soils will become salt affected and/or toxic pollutants will damage roots. Quick reference to Figure 5 shows that it takes from 2 to 4 inches of water to saturate the upper foot of most soils. Trees should have roots well in excess of 2 feet deep. Properly irrigated and in the absence of any barriers, most urban trees root to a depth of 3 to 4 feet. It is important for reasons of nutrition, water availability and support, to maintain live roots in as large a volume of soil as possible. In order to do this, deep soil layers must be irrigated as well as the surface soil. Aside from lack of provision of drainage to remove excess irrigation water, frequent applications of small amounts of water is the greatest problem for irrigated trees.

Frequent applications of small amounts of water are very hard on trees. If the soils below the zone wetted by light irrigations remains dry, roots in the dry soil will die. New roots will grow where the moisture is, causing the tree to be shallow rooted. If on the other hand, the deeper soils remain saturated, the roots in them will suffocate and die and new roots will be produced near the soil surface where oxygen is available. This too produces a shallow-rooted tree.

With coarse soils we can usually bring the upper two feet of the soil to field capacity by applying 2 inches of water. Some medium and fine textured soils will require 3 to 4 inches. Applying this amount of water weekly in the summer will aid tremendously in maintaining properly rooted, healthy trees. In spring and fall the trees demand for moisture will reduce the frequency of application.

It is worth reiterating that we are not taking about just keeping the leaves from wilting. Trees under moisture stress have difficulty obtaining scarce nutrients. The larger the volume of soil from which a tree takes up water, the larger the soil volume from which it can obtain scarce nutrients. Thus, trees that exploit a large soil volume are less likely to be deficient in phosphorus or micronutrients. Also the larger the rooting volume of the tree, the more stable or wind firm the tree. A tree rooted into a large volume of soil can better withstand drought and is better able to withstand heat and drought stress. Stressed trees are very susceptible to attack by a wide variety of insects, mostly bark beetles, and diseases.

Contamination of Urban Soils

A rather unique problem of urban soils is contamination with debris, litter, and pollutants such as heavy metals, salts, petroleum products and other organic compounds including pesticides. This is particularly true where redevelopment or residential expansion into previously industrial areas occurs.

Many industrial and commercial businesses pollute the soil. Service stations and petroleum storage areas have soils contaminated with gasoline, motor oils and lubricants. Many businesses, including construction crews, use crank case drainings and waste oils to quell dust from open or graded lots. Although these compounds are biodegradable, the decomposition takes a long time and may leave heavy metal contaminates behind. Speciality small-business such as printers, assayers and chemical-manufacturers are notorious sources of heavy metal contamination. Soil sterilants and long residual herbicides may be applied to soils for industrial weed control and fire fuel management in waste areas, beside drives, around parking lots and along fence lines. With redevelopment, these areas may become unsuccessful planting sites. The soils along the right-of-way corridor of I-80 running through Reno, Nevada, has been treated yearly since the freeway opened, 20 plus years, with soil sterilants to keep unsightly weeds down. In recent years many have lobbied to plant the area, but plans have always been stymied by the accumulated pollutants. The planting and money for soil reclamation has been approved, but the cost will be high.

Some contaminates (e.g. salts) can be effectively leached from the soil. But in most cases the contaminated soil must simply be removed and replaced with clean soil. Adding new "top soil" is not an appropriate solution since trees root deeply and will quickly recycle the contaminates, particularly metals, to the new surface. In urban areas it is wise to investigate prior land uses and to have soils, both existing and those used in fills analyzed whenever previous uses indicate the possibility of contamination.

Public Knowledge of Urban Soils

The general public is ignorant about soils, their characteristics and basic plant-soil relationships. This is increasingly a problem as fewer and fewer people in our specialized society have reason to work soil to produce crops. Consequently, it is difficult for people to understand soil-induced plant problems and how to correct soil conditions to improve growth and keep plants healthy.

Landscape professionals, planners, developers, contractors, all those that impact tree establishment and maintenance must be knowledgeable in basic environment-plant relations, especially soil and water management unique to urban forests. The efforts of the Urban Forester in developing and implementing awareness programs, sound management techniques and schedules and educating the public, including their colleagues, will pay big dividends in establishing a healthy urban forest.

Urban Soils Assessment Guide

The following, table 11-4, is designed as a quick reference to assist the Urban Forester, urban forestry workers and volunteers assess landscape soils for tree planting and maintenance. Familiarize yourself with the soil characteristics listed to the left of the table, how each limits plant growth and how they are detected and corrected. Some are easily observed and others require laboratory testing. Interpret the results as they relate to each unique planting and if necessary, seek professional analysis from your County Extension Agent or local landscape consultants. Refer to this chapter for help. After weighing alternative plans of action, which may require an economic analysis, proceed with the corrective measures. Suggested courses of action must consider the planting site's environment, what the planting is to accomplish and any economic constraints. Remember, often the cheapest, short-term "fix" costs the most in the long run, creating unnecessary or increased annual maintenance costs, even total reclamation and replanting.

Simple soil observations are made as needed with a shovel, soil auger, trencher or backhoe, before, during and after construction. Be observant during construction while trenching utility lines, excavating basements and digging the planting holes. Many potential soil-tree problems can and should be eliminated prior to planting trees. Laboratory soil testing is required to determine several important soil characteristics and to obtain a definitive analysis of general observations (Table 11-4).

Table 11-4. Guide to Assessing Urban Soils for Tree Planting and Maintenance

Soil Characteristics	Problematic Range[1] Low	Medium	High	Corrective Measures for Consideration
Morphological				
Depth to bedrock	>10'	<4'	<2'	Add top soil
Seasonal Water Table Depth	>10'	<4'	<2'	Remove source, improve surface drainage, install subsoil drains, Select trees tolerant of short-term standing water
Apparent Water Table Depth	>10'	<6'	<4'	Same as above
Restrictive Horizons	>10'	<6'	<4'	Improve structure and/or install surface and subsurface drainage
Impermeable layers	>10'	<6'	<4'	Deep till to break up or same as above or both
Disturbed and Mixed Horizons and Profiles		variable		Add organic matter (OM) and mix well, DO NOT bring subsoil to surface
Cuts, Remaining Top Soil Depth	>4'	<2'	<1'	Replace top soil (blend into top of subsoil), DO NOT remove topsoil to subsoil
Fill Soil		variable		Match new texture and structure with and blend into existing soil; deep, uniform fill is best
Fill Depth Over Roots	<6"	1'	>1'	Soil porosity dependent; avoid fine-textured and poor-structured fill. add OM; install aeration tile at root level before covering
Excessive Slope		variable		Stabilize mechanically, terrace, add top soil and OM, drip irrigate, eliminate traffic, plant soil stabiling species
Soil Erosion, in/yr	<0.1"	<0.25"	>0.25"	Reduce slopes, irrigation rates, wind and traffic; plant groundcovers and windbreaks; mulch and terrace
Wet, Putrid Soils	Brown	Tan	Gray, Black	Remove source of stagnant water; install surface and subsoil drainage then incorporate coarse OM
Soil Structure Massive, Platy		present vs. absent		Provide drainage, incorporate coarse OM, deep till

1. Approximate determinations, subject to site parameters and subjective judgement
2. Requires determination in a soil testing laboratory

Table 11-4. Guide lo Assessing Urban Soils for Tree Planting and Maintenance. (Cont'd)

Soil Characteristics	Problematic Range[1] Low	Medium	High	Corrective Measures for Consideration
Physical				
Soil Textures				
Sand	<50%	>75%	>90%	Add OM, irrigate frequently
Clay, Kaolinitic[2]	<25%	>50%	>65%	Add OM, DO NOT over irrigate, reduce traffic and compaction
Clay, Expandable[2]	none	any	>10%	Reclaim with gypsum and leaching, DO NOT plant perennials until reclaimed
Clay & Silt	<30%	>50%	>75%	Add OM, irrigate correctly, deep till, aerate and reduce compaction and traffic
Structure,		variable		Eliminate compaction, traffic, add OM; manage beneficial micro-organism and root growth; reduce sodium concentrations; DO NOT over roto till, especially at high RPMs
Bulk Density[2], Mg/m^3				
Clay	<1.1	<1.4	>1.5	Add OM; deep till
Loam	<1.2	>1.5	>1.7	Same as above
Soil Crusting		variable		DO NOT leave bare soil; add OM and mulch; grow groundcovers; eliminate traffic and reduce droplet size of irrigation spray
Aeration Porosity[2], % large pore volume	>5	<2	<1	Add OM; deep till, eliminate traffic and compaction; increase earthworm population
Soil Permeability, Infiltration and Percolation Rates, in/hr	>0.50	<0.25	<0.20	Add OM; deep till, aerate; use mulches, adjust irrigation rates accordingly
Debris and Litter		variable		Remove from soil surface and profile where possible
Temperature	Extreme hot or cold soil is influenced by exposure, elevation, latitude, water content, nearness to a large body of water, etc. Select adapted plants, use mulch, shade soils; use raised beds with heavy, wet soils and maintain adequate soil moisture; drain wet soils			

1. Approximate determinations, subject to site parameters and subjective judgement
2. Requires determination in a soil testing laboratory

Table 11-4. Guide to Assessing Urban Soils for Tree Planting and Maintenance. (Cont'd)

Soil Characteristics	Problematic Range[1] Low	Medium	High	Corrective Measures for Consideration
Chemical				
pH[2]				
Acid Soils	<7-6	<6.0	<4.0	Add lime, select low pH-adapted species
Alkaline Soils	7-<7.5	>7.5	>8.5	Add OM, sulfur, and acidifying fertilizers, select high pH-adapted species
Cation Exchange Capacity[2] (CEC) meg/100g	>10	>5	<3	Add OM and soil amendments with high CEC; fertilize regularly
Fertility[2]		variable		Test N, P, and K levels and micro-nutrients commonly deficient or toxic; add OM and encourage micro-organism growth; adjust the pH; use low demand, adapted plants; if deficient, DO NOT over water; leach if toxic levels occur
Salt-Affected Soils[2]				
Saline; EC mmhos/cm (dS/m), pH < 8.5, ESP (SAR) < 15%	<2.0	<4.0	>4.0	Sensitivity is species specific, leach saline soil, add OM, use good quality leach and irrigation water
Sodic; EC mmhos/cm (dS/m), pH ≥ 8.5, ESP (SAR) ≥ 15%	4.0	<6.0	>6.0	Add gypsum and leach; in calcarious soils add sulfur, lime sulfur, iron sulfate, aluminum sulfate and leach, add OM
Sodic-Saline; EC mmhos/cm, pH < 8.5, ESP (SAR) ≥ 15%	4.0	<6.0	>6.0	Same as above
Chemically Polluted[2] Soils	numerous chemicals & concentrations			Identify the polluting chemicals; detoxify, leach, remove or abandon site; train personal to prevent; stockpile construction materials and chemicals off site; avoid spilling pollutants; monitor storage tanks for leaks, repair immediately

1. Approximate determinations, subject to site parameters and subjective judgement
2. Requires determination in a soil testing laboratory

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XII. MAINTENANCE

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MAINTENANCE

The community forest represents a large investment which is well worth keeping in good health. Good maintenance practices will increase the beauty, usefulness, longevity and value of trees. Protection and enhancement of the community forest through consistent tree maintenance is a critical component of every community forestry program. This section will discuss the why, when and how of basic tree maintenance practices.

Watering

The relationship between plants and their surrounding soil is complex and has many contributing factors, depending upon the species of plant and the structure and chemical characteristics of the soil. Trees and other plants obtain moisture and nutrients from the soil through their roots. Most plants also require a well-aerated soil for root growth and proper function. Plants are exposed to a cyclical soil moisture pattern in the root zone. Precipitation or irrigation recharges the soil with water, increasing the soil moisture. The soil moisture then gradually declines due to evaporation, plant uptake, and gravitational water movement out of the root zone, until replenished by the next rain or irrigation. Declining soil moisture increases the air content of the soil. An extended period of low soil moisture, with an over abundance of air within the soil, can lead to desissated roots and plant death. Conversely, extended periods of soil saturation, with inadequate soil air content, can also lead to plant death. Soil moisture availability is a critical factor influencing plant establishment and health.

Recommendations on watering are difficult to make because varying climate conditions, soil types and site conditions dictate the appropriate watering techniques, including frequency and quantities of water applied. Some general recommendations on watering follow; adapted primarily from the *Manual of Landscaping Management* (Gilcrest and Holland, 1978.)

Established trees should be watered enough to penetrate the soil to a minimum depth of 10 to 12 inches and wet an area outside the drip-line of the tree where the absorbing roots exist, as illustrated in Figure 12-1. Applying about two inches of water per week will generally meet this requirement, depending on the soil type, the needs of the plant, and the climate. For instance, sandy, well-drained soils may require watering twice a week,

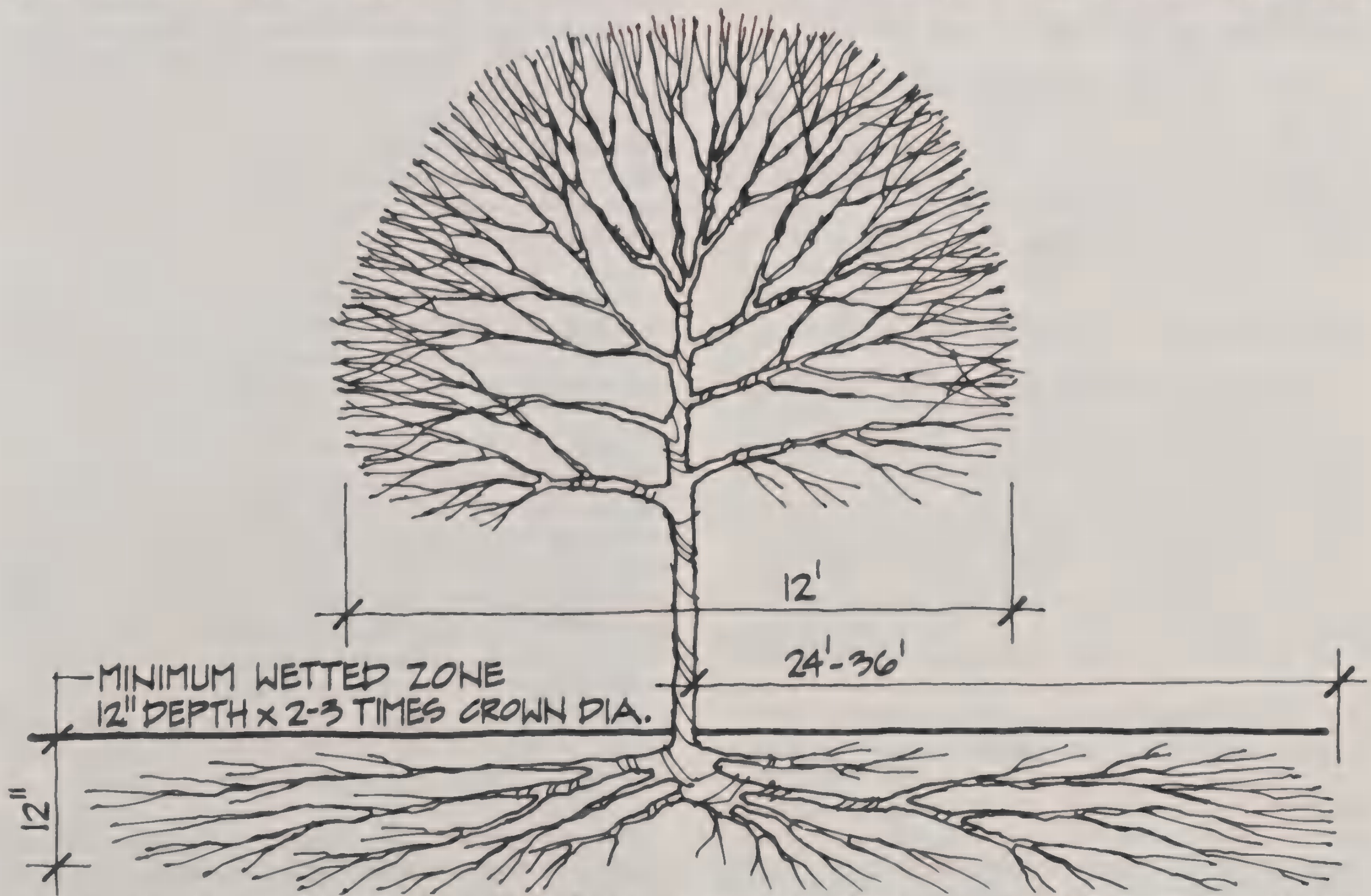

Figure 12-1. Proper Watering Will Allow Water to Penetrate Deeply Into the Soil Profile and Wet An adequate volume of soil about the tree.

applying only one inch of water each time. Avoid shallow watering, as roots will tend to stay near the surface where the water is provided. Likewise a continually over-watered tree will be shallow rooted, because the lower soil depths will be saturated and roots will only be able to grow near the soil's surface where oxygen is available. Remember, roots grow only where moisture and oxygen are available.

Often city trees are grown in planting pits with a reduced soil and rooting volume between sidewalks and roads. Tree water relations are seldom good, especially as the tree grows larger and the roots fill the pit. Fluctuations between drought and water-logged conditions becomes the norm rather than the exception. In both cases, absorbing roots are lost, the tree is stressed and growth impeded. As well, water-stressed trees become readily open to insect attack and disease invasion. They often decline slowly and die within 10 to 15 years after planting. If a particularly stressful climatic condition occurs they will die abruptly. Adequate drainage, irrigation and most importantly, a well-structured, resilient soil must be provided at planting, all within a design that allows roots to "break out" from the planting pit under sidewalks into adjacent soils, if available (see Figure 9-9 [Urban's Design]). In any case, to be successful in developing large, mature trees proper irrigation management is essential, similiar to growing trees hydroponically in sand culture.

Check the soil periodically to monitor soil moisture in the root zone, and to determine how frequently watering is needed. To do this, take a soil sample from a depth of eight to ten inches. Squeeze the sample in your hand. If it sticks together, additional water is not needed. If the sample crumbles, soil moisture is inadequate and water should be applied. Water regularly if rainfall is insufficient to recharge the root zone.

All trees and shrubs need water regardless of the season. Supplemental watering is especially needed during the summer months because the combination of high temperatures, low humidity, and inadequate precipitation will cause drought stress in most unirrigated plants. In late August, gradually reduce the frequency of deep watering. This will cause the late growth of woody plants to harden off so that it will not be injured by early fall cold or freezing temperatures.

In areas where the surface soil freezes, it is important to soak the soil surrounding woody plants before the soil freezes, but after the trees have become dormant, to maximize soil moisture below the frost zone. Winter precipitation cannot penetrate the frost zone, and cannot adequately recharge the moisture of the soil below the frozen soil. The soil below frost can become moisture deficient through continued plant uptake, creating a winter drought even if significant unfrozen surface water is available. This leads to plant injury or winterkill by dehydration, particularly after a dry fall and a winter with very cold, low-humidity winds. Evergreens are most susceptible since their foliage remains during the winter. With sunny, warm winter days, evergreens become active and demand water. However, dormant deciduous plants also lose a great deal of water from the trunks and twigs, leading to winter drought stress.

Deep-root watering of all woody plants during a dry fall and winter is a sound horticultural practice. Effective winter watering can be done when the ground around the plant root zone is thawed and when the air temperature is above freezing. Water woody plants at least once during each month that snow or rain does not provide one inch or more of precipitation.

Newly planted trees take at least one full growing season to establish their root systems. The limited root systems typically established under nursery conditions necessitate that new plantings receive frequent and thorough waterings until they develop a more extensive, normal root system in the soil of the planting site. Every newly planted woody plant should be well watered at planting to eliminate large air pockets and settle the plant firmly in place. Thereafter, water twice each week as climate and site conditions dictate. If the plant's leaves begin to wilt and the subsurface soil feels dry, the plant should be watered more frequently. However, if the leaves wilt and the soil is moist DO NOT IRRIGATE. The tree is wilting for lack of oxygen about the roots because the soil is water-logged. Drain the site immediately.

During extremely hot weather, more water may be required. Trees in locations exposed to winds or full sun may require more frequent watering. However, be careful not to overwater the plant.

Newly planted trees and shrubs should have a slight berm formed above the soil grade around the base of the plant. This "area" will hold water over the root ball and prevent runoff during irrigation. Mulch added to the soil surface within the berm confines will reduce evaporation. Fill the berm with water at each watering. The water will then be able to slowly seep into the root zone. This is an efficient and economical way for communities to insure the survival of newly planted trees. Remove the berm after establishment of the tree, usually after one or two seasons.

In most communities, watering residential street trees is the responsibility of homeowners. Sprinkler systems are often used for watering areas in which trees are surrounded by lawn.

Sprinkler system spray heads disperse water to large areas and are typically run only long enough to adequately water the shallow roots of the lawn. For a sprinkler system to supply sufficient water to reach the root zone of trees, the watering schedule must include a longer watering each week. This overwaters the lawn but replenishes the moisture in the tree root zone. An effective alternative method is to supply supplemental water directly to each tree by setting a hose under and around the tree crown. A low velocity pencil-size stream of water will saturate the root zone after several hours.

Trickle and drip irrigation systems have recently been developed to distribute water at low pressures and volumes more directly to the root zone. These systems can be programmed to provide adequate water to plants with a wide variety of water needs. However, drip irrigation systems must be designed properly with the idea of expanding the wetted area and volume of water supplied as the tree grows.

Water from an individual drip emitter wets an onion-shaped volume of soil below it. The shape of the wetted onion is dependent upon the soil structure and texture and the amount of water applied. Well-structured or sandy soils contain large pores that drain well and produce an elongated wetted volume; whereas, fine-textured clays and silts and organic soils wet as a more rounded volume of soil (Figure 12-2). Roots grow where oxygen and moisture are and consequently they often only grow within the wetted volume of soil (Figure 12-1). One emitter may adequately meet the needs of a small tree, but as it grows and seasonal weather conditions change the tree will become stressed because one emitter cannot meet the water demands of the tree. Likewise, even if one or two emitters were to meet the water requirement of the tree for several years the poorly-developed root system may not be sufficient to support a large crown and in severe winds will be up-rooted and wind-thrown.

A properly designed and maintained drip irrigation system will allow for one of two scenarios. The desgin will; 1) call for the original installation of enough emitters and line to support a mature tree or 2) schedule the periodic addition of emitters and line based upon tree growth and climatic demands. In the first case, over watering can be prevented by reducing the application rate at each emitter by using adjustable emitters or those with on/off settings, or by scheduling less time for each irrigation. Unfortunately, the cost of the original installation is more and the potential for vandalism may be greater. In the second, emitters and lines will be added as the tree grows and conditions demand. This requires that maintenance personnel be informed of the proposed expansion schedule, that personnel will be available to make the expansion and that future budgets will be adequate to purchase the materials and cover the labor costs for the additional installation. In either case, an adequate supply of water must be available as the trees grow larger and mature. The original design of the system must include sufficient expansion capacity or either scheme will not work and the tree will slowly decline and eventually die.

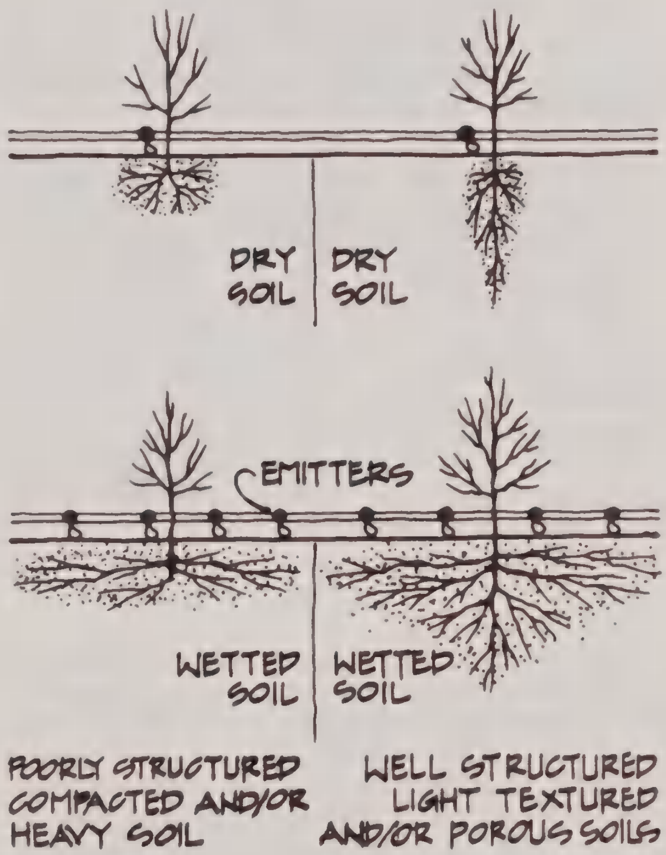

Figure 12-2. (Top) Shape and volume of wetted soil by a single drip emitter is dependent upon the texture, structure and porosity of the soil as well as the amount of water applied at the emitter. Notice the roots grow within the wetted soil only. (Bottom) More emitters would expand the volume of soil wetted and increase the development of the root system as the tree grows.

Fertilizing

Fertilization is an important part of any successful tree maintenance program. Plant nutrient deficiencies cause growth abnormalities and make plants susceptible to environmental stress and to insects and diseases. "The application of fertilizers improves the appearance and condition of trees and in some cases enables the trees to better withstand future attacks by

parasites" (Pirone 1978, p.57). However, fertilizer is a supplement to the soil. If the growing site soil is inherently nutritious for plant growth, fertilizing trees is not necessary.

Tree roots do not obtain their food for growth directly from the fertilizers added to the soil. Trees manufacture their own food in their leaves through the process of photosynthesis. Nutrients absorbed from the soil are necessary for photosynthesis and other plant metabolic processes.

Plants absorb most mineral elements from the soil solution. The elements in the soil may be divided into three classes: nonessential; essential and abundant; and essential and critical.

The nonessential elements such as silicon, aluminum, and sodium, along with many others, are believed to have no role in plant nutrition.

Essential and abundant elements include iron, calcium, magnesium and sulfur. All of these are essential to plant growth and are usually present in soils in various amounts. However, one or more of these elements can be deficient or not available to the plant. For example, pin oaks and silver maples growing in the alkaline soils typical of many of the western states often develop yellow or chlorotic leaves because iron is low or unavailable to the trees.

The essential and critical elements include nitrogen, phosphorous and potassium, and in some cases magnesium, manganese, boron and the rest of the essential elements discussed earlier, in Chapter XI. The lack of these elements often limits plant growth. This is especially true of nitrogen, which is readily leached from the upper soil levels by water. All "complete" commercial fertilizers contain nitrogen, phosphorus and potassium, in that order. The percentage of these elements is expressed by formulas such as 12-8-6, 6-8-4 or 16-0-0. The first number denotes by weight the percentage of nitrogen; the second, the percentage of phosphorus; and the third, the percentage of potassium. Thus a fertilizer with an analysis of 12-8-6 contains 12 percent nitrogen, 8 percent phosphorous, 6 percent potassium. The remaining percentage is the carrier material and filler. Labels of complete or balanced fertilizers will list percentage values for these three essential elements. Many fertilizer companies add small amounts of the more scarce but essential elements such as boron, magnesium and manganese to their standard formulas. These are sold as complete fertilizers and identified as having "minor elements" added.

The four primary decisions in a fertilization program are (1) fertilizer selection, (2) method of application, (3) time of application, and (4) rate of application.

Fertilizer Selection

Selection of a specific fertilizer formula depends on soil characteristics. Coarse textured sandy soils have a low fertility potential due to a low cation exchange capacity (CEC) and the resulting loss of nutrients due to leaching. For these soils it is advisable to select a slow-release fertilizer containing nutrients which slowly dissolve in water. The application of water soluble forms at lower rates and more frequent intervals is appropriate on finer textured and organic soils, which have a higher clay particle content that enables greater retention of nutrients.

The soil pH can be manipulated to some extent through fertilizer selection. For example, the pH of soils will increase if they are irrigated with water containing calcium and magnesium. The use of acidifying fertilizers such as ammonium sulphate, ammonium nitrate or ammonium phosphate can increase soil acidity and maintain the soil pH in a more favorable range for plant growth.

The handling and storage characteristics of different fertilizers are another consideration when selecting a fertilizer. Fertilizers of a uniform particle size usually cost more but give a more uniform application than those with a nonuniform particle size. Fertilizers with carriers that are light in weight can be handled with less effort than heavier or bulkier types. It is also desirable to select fertilizers which tend not to attract moisture and cake during storage.

The costs of fertilizing should not be ignored. There is a large price variation between types of fertilizers in terms of the actual quantities of nutrient contained. Fertilizers in a more soluble form tend to have a short effective duration (4 to 6 weeks), requiring more frequent applications. These fertilizers usually cost less per unit of nutrient, but the labor cost of repeated applications is greater than for "slow-release" forms, which are effective from 10 to 14 weeks and generally cost more per unit of nutrient. Thus, the urban forester must evaluate these trade-offs in terms of the labor, maintenance schedule and budget.

Methods of Application

Fertilizing trees can be done by subsurface application, broadcast surface application, and by foliar spraying. The techniques and pros and cons of each method will be discussed below.

Subsurface fertilization is considered by many to be the best method for fertilizing trees. The

objective is to place the fertilizer directly into the root zone. A punch, drill, or liquid fertilizer probe is used to make a predetermined number of holes in the soil around the tree. Granular fertilizer, slow release pellets, or liquid fertilizer is then placed in each hole, into the zone of the tree's non-woody, absorbing roots. Automatic and compressed air equipment is available that mechanically drills the holes and dispenses the fertilizer in a single operation.

There are several considerations to be made with this fertilization method. If the tree has a shallow root system, punched or drilled holes may go too deep, leading to placement of fertilizers below the root zone, beyond benefit to the tree. The use of slow release pellets helps to avoid localized, highly concentrated pockets of fertilizer which can be toxic to adjacent roots. Injecting liquid fertilizer through a hollow probe with water pressure disperses the fertilizer more completely through the soil layers, and may help reduce soil compaction, but regulating fertilizer dosage can be difficult.

The holes for subsurface fertilization should be at least 8 inches, but not more than 24 inches in depth, since most of the non-woody, absorbing roots are within 2 feet of the surface (Shigo, 1986). Locate holes in a doughnut shaped pattern around the tree, beginning halfway between the trunk and the dripline, and extending beyond the dripline by the same distance (See Figure 12-3). Stagger the holes about 18 inches apart (24" for large trees). If the area beneath the spread of the branches is restricted (i.e. building wall, sidewalk), reduce the fertilizer application in proportion to the number of holes that cannot be made. For holes larger than 1 inch in diameter, backfill them after inserting the fertilizer to encourage lawn or ground cover reestablishment. Otherwise, leave the holes open to improve soil aeration and water infiltration.

To calculate the number of fertilizer holes to be bored, you must know the crown diameter and the planned hole spacing.

Compute the area of a circle with a radius of 1.5 times the distance from the tree's trunk to the dripline. Subtract from this area the area of another circle with a radius of 0.5 times the distance from the tree's trunk to the dripline. The resulting figure is the area to be fertilized. Divide this by the squared distance between holes to obtain the number of holes to prepare.

After calculating the number of fertilizer holes, determine the amount of fertilizer to insert in each hole. This will depend on the desired rate of application and the percentage of the essential elements in the fertilizer. Follow the manufacturer's recommendations on application rate. Use

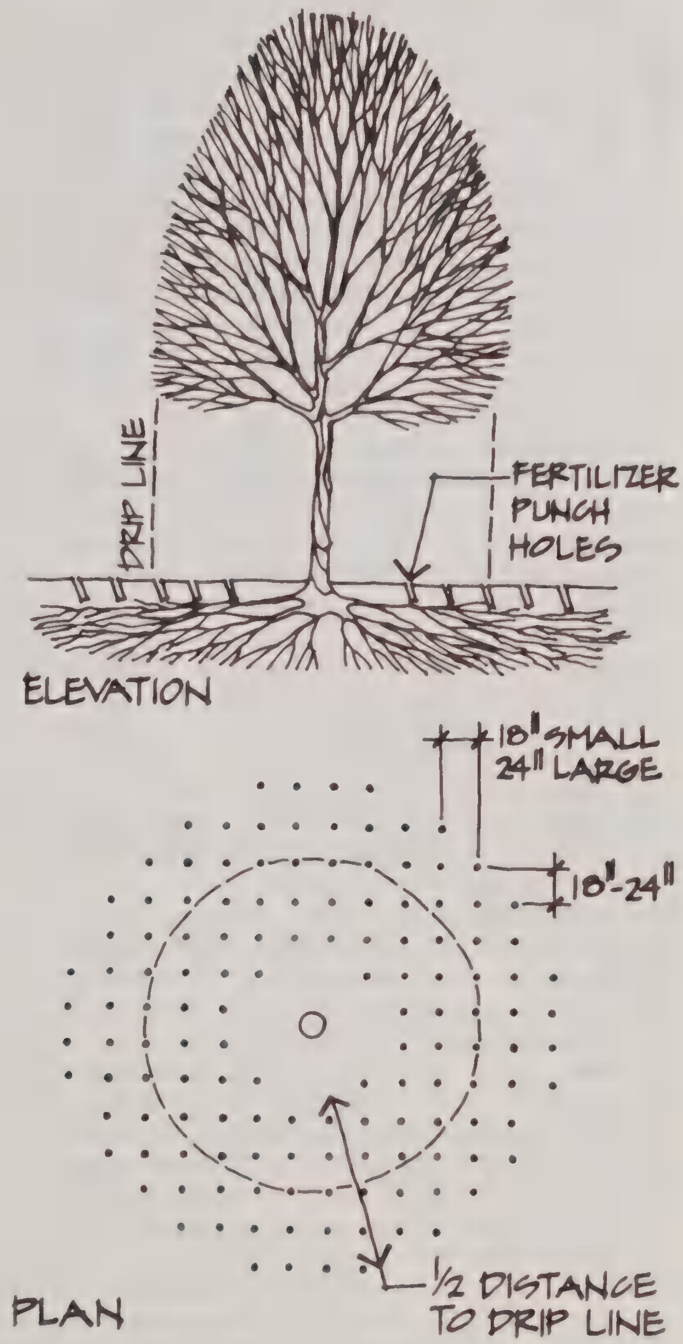

Figure 12-3. The Punch Hole Technique Is an Effective Way to Fertilize Deeply Watered Trees with Well Developed Root Systems

a funnel to avoid spilling fertilizer on surface vegetation. The following example is presented to illustrate how to determine the correct amount of fertilizer per hole.

A tree with a 12-inch trunk diameter at breast height and a symmetrical 35 foot crown diameter is to be fertilized. A 50 pound bag of a complete granulated fertilizer with a 12-7-6 + iron formulation has been purchased. If the recommended application rate is **one-half pound of actual nitrogen** per diameter inch of tree trunk, then 6 pounds of actual nitrogen will be needed. The

number of pounds of actual nitrogen in the 50 pound bag can be found by multiplying the percentage of nitrogen (0.12) times the weight of the bag (50 lb.). There are 6 pounds of actual nitrogen in the bag. Thus, the contents of the 50 pound bag are sufficient, but they must be distributed equally into each fertilizer hole. Using a crown radius of 17.5 feet and a hole spacing of 2 feet yields 480 holes. Determine the amount of fertilizer needed per hole by dividing the weight of the bag (50 lbs.) by the total number of holes (480). The calculation results in an application rate of .10 lbs. (1.6 ounces) per hole.

Broadcast surface fertilization can be an effective method to fertilize trees, and is less labor and cost intensive than subsurface fertilization techniques. A granulated fertilizer is spread evenly over the ground surface above the root zone. The area must then be thoroughly watered to move the fertilizer down into the tree's root zone. Thorough "watering in" is also necessary to avoid injuring lawns or other ground covers upon which the fertilizer is initially spread and to discourage development of shallow tree roots. Such shallow root systems are in competition with lawn roots for water and nutrients, which makes the tree more susceptible to moisture stress and windthrow.

Foliar fertilizing, which involves spraying a water-soluble fertilizer directly on tree leaves, can be done with a hose sprayer. Nutrients are absorbed by the leaves, and to a minor degree by the bark, buds, petioles and flowers. This method provides quick response, but short term results compared to soil application of fertilizers. For example, chelated iron can be applied as a foliar spray to reduce symptoms of iron chlorosis (the yellowing of leaves due to iron deficiency) However, only the leaves are affected and the results are lost when the leaves drop.

The amount of high analysis all-soluble fertilizer to use when foliar fertilizing will vary with the formula. In general, no more than the following amounts should be dissolved in 10 gallons of water: 5 ounces of a 12-12-12, 13-13-13 or 13-26-13; 4 ounces of a 15-15-15, 15-30-15, or 16-16-13; 3 ounces of an 18-18-18, 20-20-20, or 23-21-17. Spray the tree until the nutrient solution begins to drip heavily from the leaves. Spraying should be done in cool weather to avoid chemical burning of the leaves. Rain occurring after or within 1 to 2 days of application will wash the fertilizer from the tree, defeating the purpose of the foliar fertilization.

Time of Application

Evergreen trees are best fertilized in spring. Deciduous trees should be fertilized in either late fall or early spring. Fall applications should not be made until dormancy has begun. Fall applications are advantageous in that some nutrients will enter the roots immediately and some in very early spring. The remainder will be available throughout the following growing season. Fertilizer applications in the spring may be made from the time the frost is out of the ground up until bud break. Late summer and early fall applications are not recommended because such treatments stimulate the development of new succulent growth, which does not harden properly and is subject to fall frost injury.

Nitrogen, an essential element, should be applied at least every two to three years. Applying phosphorous and potassium every three to five years is generally adequate for satisfactory growth. Using a balanced, complete fertilizer to meet nitrogen needs will provide the other elements in sufficient amounts.

Rate of Application

There is a wide range of opinions as to how much fertilizer should be applied. Recommendations range from 1/2 to 8 pounds of a complete fertilizer per inch diameter of the trunk at breast height. Pirone (1978) recommends applying between 2 to 4 pounds of active ingredient in a fertilizer per inch of tree diameter at breast height. Frequency of application depends upon the trees needs. Trees less than 6 inches in diameter should get half this amount. Additionally, consider the age of the tree and the desired results. If the tree is young, in average to poor soil, and you want it to grow rapidly, then fertilize with a formula high in nitrogen. Relatively little or no fertilizer should be applied to an older tree that is to be kept in good vigor without encouraging further growth.

Pruning

Pruning is an integral part of urban forest maintenance. Although pruning wounds a trees and provides greater access for attacking insects and diseases to envade, correct pruning can greatly assist in maintaining the health, appearance and vigor of trees. Early training and regular pruning corrects minor defects that would otherwise eventually require major tree surgery. Thus, pruning serves the following purposes (not listed by priority):

1. To control the size of plants.

2. To encourage trees to develop their natural form and ornamental character.

3. To remove dead, damaged, weak, diseased or crossing limbs and roots.

4. To stimulate future flower and fruit development.

5. To minimize or avoid the danger of personal injury, property damage, and ensuing liability claims by removing low-hanging, unsound, dangerous limbs, shallow roots, and even whole trees when necessary.

6. To ensure the public safety by eliminating conflicts between tree limbs and sign visibility, intersection visibility, and utility lines, and tree roots that interfere with sidewalks, curbs.....gutters, as well as sewer, gas and other utility lines.

Timing of Pruning

The time to prune depends on the kind of tree, the results desired, the urgency of the situation, and the availability of skilled labor and necessary equipment. Late winter or early spring is the best time to prune most deciduous shade trees due to the facts that this is when limb placement and tree form can be easily seen in deciduous trees and wounds close most rapidly. Some trees such as the maples, birches and elms are known as "bleeders", and are best pruned in late summer or fall. The sap dripping from spring wounds is not usually harmful to the plant, but heavy and persistent dripping is unsightly, paricularly if invaded by bacteria and fungi.

Trees that flower before the end of June produce flower buds on the previous season's growth. To maximize flowering, early spring flowering trees such as the Redbuds, Hawthorns and Crabapples should be pruned immediately after flowering. Trees flowering after the end of June, such as the Japanese pagoda tree, golden rain tree and crape myrtle, form flower buds on the current season's growth, and should be pruned in the winter or early spring. Pruning can be timed to enhance or reduce flowering and consequently fruit production.

To reduce confusion, develop a maintenance schedule which divides plants into pruning categories based on their flowering and fruiting times.

Evergreens are classified either as broadleaved and narrow-leaved and each requires special consideration when pruning. Most narrow-leaved evergreens are conifers with an excurrent (straight, single leader with whorled branching) growth pattern. In cooler climates they usually flush or grow only once each year; in the spring. In warmer climates, pines often flush several times a year. Pruning should avoid disrupting this excurrent growth pattern if at all possible.

Prune for shaping and growth control by removing a portion of the new growth after it stops growing. Avoid pruning into 2 and 3 year old wood as regrowth to fill in the void will be poor. Candles, as new growth is called, may be removed to within 1/4" of their bases and still produce buds for the next flush of growth. Many conifers can be pruned or "sheared" after shoot enlongation is complete to shape, to control size, and to stimulate a more dense crown.

Broadleaved evergreens have a branched, spreading or upright habit similar to deciduous trees. In fact most are pruned similarly, considering flowering time, natural shape, exposure etc. Because broadleaved evergreens keep their leaves year to year, and have a tendency to produce heavy shade, more consideration must be given to thinning them and keeping the lower canopy wider than the top, to allow sunlight throughout the canopy. Lower and interior limbs grow poorly, are weak, and flower little if continuously shaded.

Avoid late summer pruning because it may encourage new growth which will not sufficiently harden to prevent winter damage. It may also deplete food reserves stored in the trunk and roots that are needed for winter survival and early spring growth. In general, most communities schedule street and park tree pruning in the winter in order to distribute tree maintenance work more evenly over the entire year.

Training Young Trees

Directing the growth of young trees is essential if mature trees are to perform properly in the landscape. The following discussion (adapted from *Pruning Landscape Trees*, Harris et al., 1981) is intended to help the arborist achieve desirable branch placement and structural strength in young trees to minimize future maintenance needs.

Consider the natural growth habit and landscape use of each plant to be pruned. Trees with a strong central leader, such as Sweet Gums and the conifers, may need little training. Other tree species may need considerable pruning. For example, the Mulberry grows irregularly, the Modesto Ash has poor branch structure, and Flowering Crabapples develop vigorous suckers and watersprouts. Street trees require higher crown development for clearance than do trees which provide screening or windbreaks. Prune young trees only enough to effectively train and direct growth, and to correct any structural defects. With light pruning, the dwarfing influence will be minimal.

When pruning is necessary, do so in accordance with the following steps. First remove

all dead, dying or diseased wood. Next, stand back from the plant and examine its form to determine which branches should be saved as major limbs. Select those branches which are attached to the trunk at wide angles and which are smaller in diameter than the trunk. Weak crotches are formed when the branch and trunk form a very narrow (small) angle of 35 degrees or less. In many young trees the lower branches often outgrow the trunk and upper branches. It may be necessary to remove part or all of a lower branch that threatens the dominance of the leader.

The vertical spacing of limbs is permanent and does not change as the tree grows. In many species, pruning to enhance the vertical spacing of the limbs is necessary to establish or reestablish a dominant leader, eliminate crossing limbs, provide structural strength and improve the appearance of the tree. Closely spaced limbs have fewer laterals, and result in long, thin branches with little structural strength. Consequently, they break off more easily than limbs with wider spacing. The vertical space between major branches should be at least 8 inches and preferably 18 to 24 inches. Many mature trees have branches 4 to 12 feet apart. Radial spacing around the trunk should prevent one limb from being over another, and jointly impeding growth. The lower one may be shaded out, or the upper one may be less vigorous in the presence of the lower, which competes with it for water and nutrients. Radial branch distribution should allow 5 to 7 limbs to fill the circle of space around the trunk. This can be done in one or two rotations around the trunk. Examples of good and poor branch arrangement are illustrated in Figure 12-4.

During the first two growing seasons after planting, prune young trees as little as possible. This allows the trees to use all available foliar resources to establish and develop their root systems and to overcome the stress of planting without additional stress from pruning wounds. The trunk will increase more rapidly in base diameter if laterals grow along it. Laterals also shade the trunk, reduce the likelihood of sunscald on the trunk, and act as a guard, reducing the possibility of injury to the trunk from mowers, cars, animals and vandals. Therefore, at planting time and during later dormant pruning, allow laterals of trees with weak to moderate vigor to remain as temporary branches.

Remove or headback vigorous, low-growing laterals if less vigorous ones can be selected, or if they compete with the main leader. Space temporary branches 4 to 12 inches apart. Closer spacing may unduly retard vertical growth. Most trees should be inspected several times during the growing season. It may be necessary to pinch the tips of vigorously growing temporary branches to reduce competition with the leader and permanent branches. After two or three years, when the trunks of small trees are 3 or 4 inches in caliper or those of larger trees are 6 to 8 inches in caliper, the number of temporary branches can be reduced over a 2 to 3 year period.

Avoid selecting nursery trees with numerous large, low, vigorous laterals. Some nurseries "head back" trees when they are 4 to 5 feet tall. This promotes growth and development of laterals below the cut, forming a multibranched, compact head. The tree will have good proportions when small but will have no leader. In many cases these branches are too low and too close together. Select the most vigorous and upright branch to become the leader. Choose a second branch (one high enough above the ground) to be the first scaffold. Thin other branches and treat those remaining as temporary branches.

Figure 12-4. Pruned When Young (Top) and Not Pruned When Young (Bottom). Adapted From TREE CITY, USA Bulletin No. 1 National Arbor Day Foundation

Weak, young trees may result from a number of unfavorable growing conditions or practices, either in the nursery or after planting. The difficulty may be caused by such problems as girdling or kinked roots, disease, insects, trunk

Figure 12-5. This Butcher Parks the Same Way He Prunes — Incorrectly!

sunscald, poorly drained soil, etc. You may have to resort to severe pruning in order to revitalize the tree or replace it entirely. New growth will come from latent buds below the cut. When the new shoots are 5 to 6 inches long, choose the one in the best position and pinch back the others. Often a vigorous well-branched leader will develop in the first year to revitalize the tree. Specifications for contractly grown trees should include a description of the desired pruning practices and expected results as discussed above.

Pruning Mature Trees

While the best time to train and shape shade trees is when they are young, it is frequently necessary to prune older trees. Trees with low, broken, crossing, dead or diseased limbs require pruning to improve their appearance and health, and to eliminate hazard. Trees that have become too large are often pruned to eliminate conflicts with power lines, vehicles and structures. Pruning mature trees is a complicated and often hazardous job. Contact a qualified professional arborist for assistance.

Pruning can remove diseased tissues. For example, pruning can reduce the spread of fireblight, a serious disease of most crabapple, pear, hawthorn and mountain ash trees. Cuts should be made in the healthy wood 18-24 inches below the infection. Shears should be disinfected after each cut with alcohol, bleach, or lysol spray. Rinse and oil the pruners after each day's use. Anthracnose is often a problem on three-to-four year old limbs of Sycamores, London Planetrees, and other species as well. Pruning the dead twigs removes the cankers from which the fungus reinfects the tree. This may somewhat reduce the disease, but its primary purpose is to improve the trees appearance.

To keep trees healthy, it may be necessary to thin the top of the tree so interior leaves and branches receive more direct sunlight. A mature tree can be opened up by removing limbs 1 to 2 inches in diameter. On small trees, remove smaller limbs. Remove limbs from the top and around the sides of the tree. Remove branches that are too close to each other. Never leave stubs. See Pruning Standards, Appendix L. Thinning can also reduce the height and spread of a tree. Cut branches to lower laterals. Some major limbs may require complete removal.

Heading, pollarding, topping, stubbing or dehorning are terms used to describe a form of severe pruning that removes practically all branches and leaves from a tree (Figure 12-5). While this method is quicker than thinning, the results, in most cases, are much less desirable. Regrowth is vigorous and upright from the stubs. The new branches form a compact head, cast dense shade and are weakly attached to older limbs, becoming very susceptible to wind, snow and ice breakage as they age. Also, the natural form of the tree is lost. There are few valid reasons for this type of pruning. To quote Barker

(1975): "reducing trees to mere limb stubs is not good pruning. If such drastic treatment is necessary, spare the landscape so caustic a blemish by removing the tree entirely." Figure 12-6 illustrates the effects of thinning versus heading on tree form and canopy density.

Pruning Evergreen Trees

Pruning evergreens may present special problems. These will be noted for each type of evergreen plant.

Broadleaf type. Plants such as the Glossy Privet and Loquat should be pruned little, if at all. If pruning is required, do it lightly, just after flowering. Make cuts just above a side branch.

Narrowleaf type. Pines, spruce and fir are pruned according to growth characteristics. Those that produce side buds on the shoots (spruce, fir, Douglas Fir) should be pruned by cutting the tips back to the desired length in early spring prior to budbreak. Make cuts just above a side bud or branch. Avoid cutting into 3 and 4 year old wood, because regrowth to fill the created void is unlikely. In plants which produce few side buds, such as the pines, pinch or snap off a portion of the elongated young growth, "candles", which complete their growth generally by mid-June. The proper time to pinch is when the new growth snaps off easily and cleanly.

Scale-like leaf type. Plants such as the junipers and arborvitae have no definite buds and may be pruned at any time when the wood is not frozen. To hide the pruning cuts, prune the plant to an upward growing branch or bud.

General Pruning Guidelines

Pruning is a dwarfing process, particularly when it removes food producing leaves during the growing season. Pruning is also a wounding process. If done incorrectly, the wounds will not compartmentalize properly leaving the tree open to insect and disease invasion. Consequently, cuts should only be made when justified. Make no cuts indiscriminantly!

Always prune with sharp tools to avoid ragged cuts which do not close rapidly (Figure 12-7). Likewise, sharp tools are less apt to cause personal injury.

Remember to clean and sanitize cutters between cuts to prevent transmission of disease when pruning a tree with disease symptoms and when moving from tree to tree and job to job. Many trees diseases may be spread about a community on the unclean equipment of careless tree trimmers.

The pruning techniques described below have proven effective, and are demonstrated in Figures 12-6, 12-8 and 12-9.

1. Do not leave large stubs. As a general rule, remove limbs all the way to the main trunk or to a new leader or remaining limb.

2. When cutting limbs back to the parent stem or trunk, do not cut so close as to damage the bark or significantly enlarge the wound. Make the cut just outside the bark ridge and "branch collar" (See Figure 12-8). This zone of tissue at the base of every branch chemically and morphologically inhibits the spread of decay into the trunk. Preserving the branch collar promotes rapid wound closure. If the collar is cut off or injured, the chances of infection by damaging microorganisms are greatly increased.

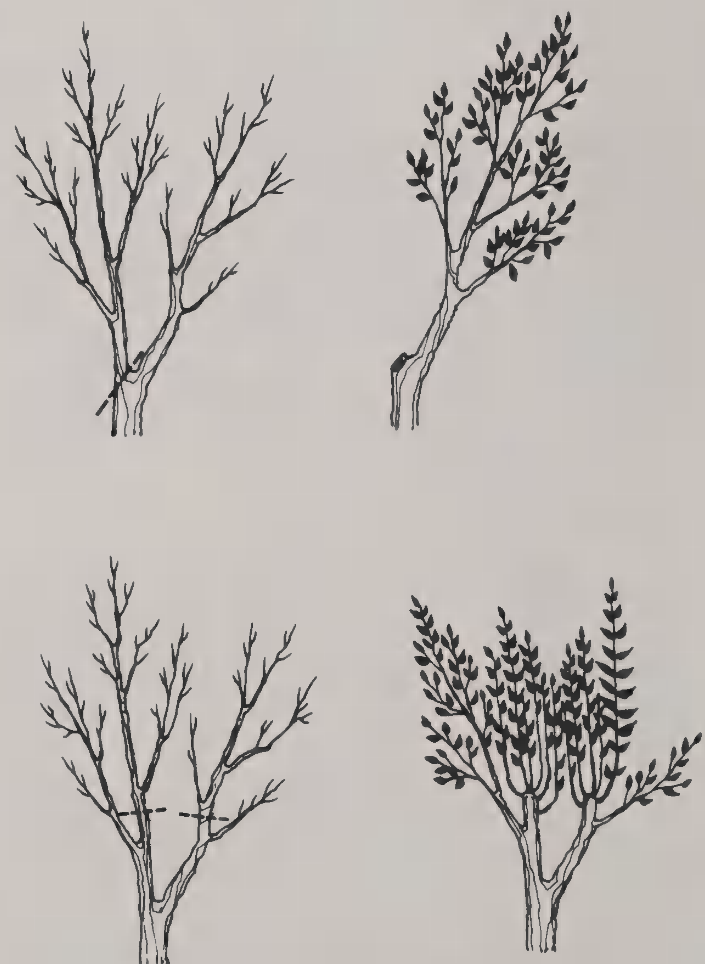

Figure 12-6. Proper (Top) and Improper (Bottom) Top Removal of Tree. Resulting Limb Growth on Right for Each Example. Improper Topping (Bottom) Results in Weakly Attached Epicormic Growth

Figure 12-7. Crew Training in Proper Pruning Techniques Can Prevent Tearing Bark and Unprofessional Work

3. The three cut method recommended for larger limbs is illustrated in Figure 12-9. Make the first cut 8 to 10 inches from the crotch or branch angle and on the underside of the limb. Cut 1/3 to 1/2 way through the limb. Make the second cut from one to three inches further out from the first cut. Start this cut from the top and cut through the limb. As the limb falls, any bark rip or break is stopped at the first cut. Make the final cut just outside of the branch collar.

4. In the past, tree paints were applied to protect the cut surface from wood decay organisms and to prevent the wood from checking as it dries. However, studies have shown that wounds treated with wound dressing had more decay than untreated wounds. Chemicals in the dressing can inhibit wound sealing as well. It is best to let the trees defend themselves. "Do not paint the cuts. Within a year the cut surfaces will turn the same color as the bark" (Shigo, 1986, p. 425).

5. Avoid damaging the leader of any single-stem plant. This results in a multiple top and destroys the natural form of the tree.

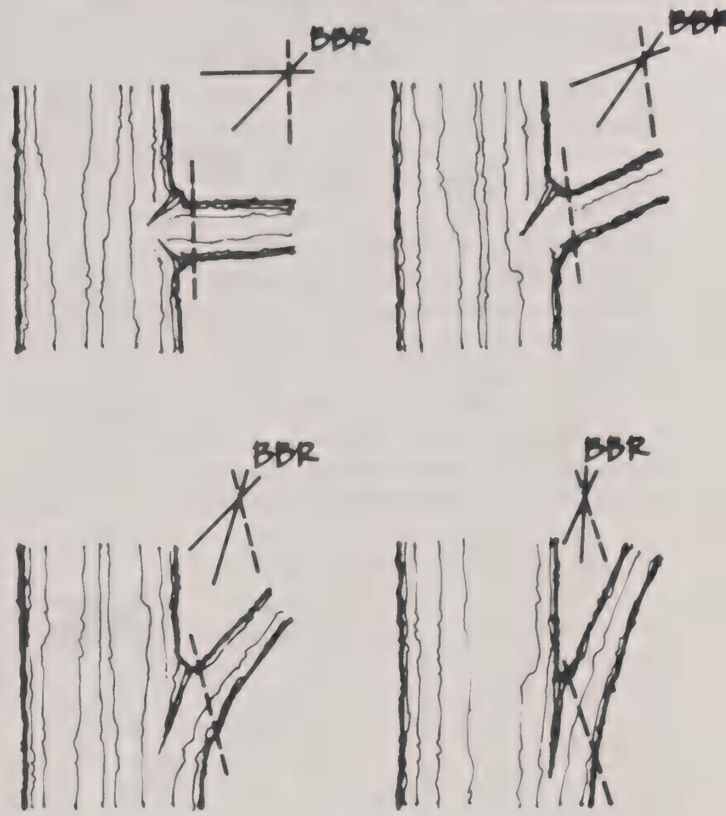

Figure 12-8. When Pruning Branches, Angle of Cut (Dotted Line) Should Be Equal and Opposite the Angle of the Branch Bark Ridge (BBR)

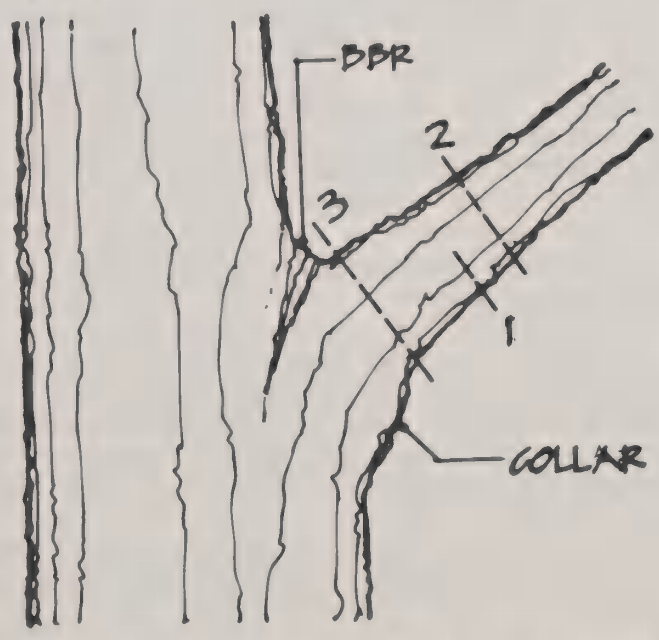

Figure 12-9. For Three-Cut Pruning Technique the Final Cut Should Be Outside the Collar and Branch Bark Ridge (BBR)

Chemical Growth Regulators

Chemical growth regulators for application to trees have been developed by several chemical companies in recent years. When injected into the trunk of the tree, applied as foliar spray or painted onto the bark of the trunk and larger limbs, these chemicals inhibit twig elongation without significantly impacting leaf development. When effective, this treatment increases foliage density and retards vertical growth for several years. The potential value of such chemicals for reducing the frequency (and cost) of trimming trees in conflict with overhead lines is great, particularly to the electric utility industry. However, appropriate rates of chemical application are highly variable, depending upon tree species, local climate and soil conditions. Excessive application rates can cause trees to be unsightly for years, and can even be lethal to stressed trees which raises serious liability issues. Long-term local trials of the chemicals are needed to determine safe rates to be used. This is an area of arboriculture research with much promise, and with many unanswered questions at present.

Sidewalk Damage

Although sidewalk damage is not a physical condition of the tree, it is a circumstance often directly associated with street trees. The typical scenario begins with a tree that was planted many years ago in a small but seemingly adequate planting strip between curb and sidewalk. As the tree matured, the base of the trunk expanded, and the roots enlarged, to a point where the available space was too small. Surface lawn watering also encouraged a shallow root system. Gradual but steady root growth exerted pressure on the adjacent cement curb, gutter, and/or sidewalk, causing them to be lifted out of original alignments and settings. The uplifted and often cracked concrete now presents a tripping hazard to pedestrians, interferes with proper gutter drainage, and is an unsightly liability to the city. The city can face almost catastrophic costs to repair this damaged concrete work. Yet these costs can be dwarfed by litigation costs associated with falls and injuries caused by the heaved concrete.

Trees are often blamed for causing the sidewalk damage. However, the original planners and tree planters are the culprits. The best solution to sidewalk and gutter damage is to prevent it by planning and planting a tree that will, **AT MATURITY**, not outgrow the available space. Good planning insures successful, longlasting plantings, and reduces future costs and liability to the city.

Planting new tree species or cultivars suitable to the available space prevents future sidewalk/ gutter damage, but does not solve existing problems of poorly planned, yet valuable street trees. The seemingly easy solution is to remove the tree, but this does not repair the damaged sidewalk/gutter! Rather than condemning the tree, and losing a valuable community asset, many communities repair the sidewalk and preserve the tree. When the damaged concrete is removed, an excellent opportunity is available to make subsurface improvements. Roots can be pruned (although the extent of this pruning must also be weighed against the loss of anchoring roots that prevent windthrow and provide water and nutrients to the tree) and a root barrier can be installed. The base material on which the new concrete will be poured can be increased in depth and gravel content to inhibit new root growth directly underneath the new sidewalk or curb. Another measure to preserve the tree and prevent recurrence of the concrete damage is to alter the location of the sidewalk so that the tree has more space.

All of these measures require recognition of a tree's value to the community and an investment of time and money to preserve and enhance that value. Coordination and cooperation with public works agencies is essential to the success of these efforts. Realignment of sidewalks may require that existing codes be rewritten, special right-of-ways be established on adjacent private property, and/or that a variance from city ordinances be approved. The process may be time consuming, but will not take as long as it would to grow another mature, healthy street tree that shades and beautifies the community.

Wound Repair and Cavity Treatment

Neglected wounds are often perceived as a major cause of decay and premature death of trees. Past philosophies and practices for wound repair have been challenged by recent research findings: "Shaping a wound is of little or no value in hastening wound closure. If you do shape a wound, take care to increase its width as little as possible, and to create an ellipse with no sharp apexes (Harris 1983, p.509). Wounds are best repaired by removing any **loose** bark in and around the wound, leaving peninsulas of live bark in the wound if possible and avoiding enlarging the wound. These measures minimize the time needed for wound closure. As stated earlier in the general pruning guidelines, **do not paint** the wound.

Shigo (1983) found that traditional cavity repairs extend the damage in the tree by breaking boundaries that the tree itself forms in response to the original wound. Cavities should not be cleaned, sterilized, drained of standing water, or filled. A cavity large enough to raise concern over

the safety and stability of a tree should be one of the major justifications for removing the tree. Protecting and properly pruning trees to prevent cavity-causing wounds is the best treatment.

If the top is lost from an evergreen, tie up a side branch to replace it. If the top is lost from a deciduous tree, prune back to a strong bud of central leader. In both situations the tree will grow normally there after.

Disease and Pest Control

To maintain a healthy urban forest, disease and pest problems must be promptly diagnosed and treated. Frequent inspections of plants during the growing season will help to avert serious damage from diseases and pests. Tree crews and the local citizenry should be encouraged to report unhealthy trees to the city forester.

Diagnosing a disease or insect problem is often difficult because visible tree symptoms may have a number of causes, including some which are not biological. The following sections are intended to provide sufficient information to reduce the possible causes of a problem. A final diagnosis can then be made by a local County Extension Agent or community forestry specialist. Recommendations for control of disease- and pest-related problems should be obtained from these or other qualified sources.

Diagnosis

Before examining the ailing tree study the general circumstances. Answer the following questions:

1. Do other nearby trees appear to be healthy? (Look for similar symptoms on trees of same species)

2. Have any recent cultural treatments (fertilization, spraying, etc.) been made prior to the appearance of the abnormal condition?

3. What surrounding circumstances (wind exposure, soil type, drainage, excavation, change in grade, etc) may have played a part in the development of the tree's current condition?

4. What insects and diseases is this tree's species susceptible to?

After these questions have been answered, determine whether or not the plant received proper care. Consider such factors as watering, fertilizing, mulch, soil cultivation, pruning, etc., over the life of the tree. In many cases, inappropriate cultural practices contribute to a tree's decline and may be the direct cause.

Other items to investigate are the past weather conditions and the possibility that herbicides (weed killer, soil sterilant, etc.) were used in the vicinity. Both of these factors may be responsible for plant troubles. Also, a soil analysis may be useful where high salts or nutritional problems are suspected.

Examination of the leaves. The leaves are often first to show the effects of any abnormal condition. Insect injuries to leaves are easily diagnosed, either by the presence of the insect or by the effect of its feeding. Leaf injuries produced by parasitic fungi and other disease organisms may be more difficult to identify because the causal agents may not be visible without the aid of a hand lens or a microscope.

Leaf structure, appearance or function may be altered by such widely different causes as deficient or excessive moisture, chemicals applied to the foliage or surrounding soil, lack of available nutrients, poor soil aeration, air pollutants, root injuries, insects or diseases. Examination of nearby trees of the same species can eliminate or confirm widespread conditions, but be aware of air and soil drainage patterns and soil character variations.

Examination of the trunk and branches. Carefully inspect the trunk and branches after examining the leaves. Cut off a section with healthy leaves from an unhealthy branch to determine if wood below the bark is diseased. Examine the bark for disruption, discoloration, or evidence of fungi or other pests. If there is a gradual change in color from the diseased to the healthy tissue, an infection is likely. Injuries resulting from high or low temperatures are usually defined by an abrupt line of demarcation between affected and unaffected tissues.

Evidence of borer infestation appears as small holes (from which sap may be running), sawdust and scars on the bark of the trunk. Because most borers attack trees of poor vigor, it is important to investigate the cause of the tree's weakened condition rather than to assume the borers are primarily responsible. This is also true of many secondary disease infestations.

Branches and twigs should be examined for small scale insects, which are usually visible to the naked eye. If the branch has wilted leaves or is leafless, take a cutting to see if the sapwood is discolored, by wilt-producing fungi. Laboratory culturing may be necessary to confirm the identity of the wilt fungus.

Examination of the roots. Roots are seldom inspected because of their inaccessibility. However, root injury and disease are responsible for many tree disorders. "The sudden death of a tree usually results from the destruction of nearly all the roots or from the death of the tissues at the trunk base near the soil line. Factors most commonly involved in such cases are infection by fungi . . ., winter injury, rodent damage, lightning strikes and toxic chemicals like gasoline, oil, salt, and weed killers. Trees that become progressively weaker over a period of years may be affected by girdling roots, decay following sidewalk and curb installations or road improvement, poor soil type, poor drainage, . . . changes in grade and excessively deep planting from the start" (Pirone, 1978, p. 190).

When a tree problem exists diagnosis of the cause will be aided by the following points adapted from *Diagnosing Landscape Plant Problems* (Feucht, 1978):

1. A general rule that can be followed is: When injury first appears at the bottom and/or inside parts of the plant, look for soil problems or internal (disease, systemic herbicides, etc.) causes. If injury shows up on the top and/or external portions first, look for environmental (air pollution, spray damage, insects, diseases, cold injury, etc.) causes.

2. Presence of an insect does not necessarily mean that the insect caused the problem. What is the insect? What damage is it causing? Are there enough insects to cause the damage seen?

3. Absence of an insect or disease sign does not necessarily eliminate these causes from consideration. An insect may have left the damage and migrated to another plant or it may have changed to another form (pupated). A disease may not have progressed sufficiently to produce spore structures or other signs.

4. Injury to one side or a portion of a plant can indicate a soil problem or root injury on the opposite side of the plant. Trees often develop a twist in trunk structure; thus roots supplying water to a given part of the tree may be located on the opposite side of the tree. Conifers have a naturally spiraling vascular system. Consequently, damaged or infected roots on these trees often cause a spiraling stress symptom in the tree trunk and/or crown.

5. Always check growth rate. Compare current growth with previous season's growth or that of earlier years. Sometimes this provides clues to the affects of past cultural practices.

Tree Problems Frequently Observed in This Region

Oxygen starvation to roots (or overwatering): most frequent in evergreens such as Pinon Pine and Bristlecone Pine. Plants suddenly lose all interior leaves. New growth may be normal at first, but if soil aeration is not soon corrected the entire plant dies. New growth usually remains on plant. General yellowing and wilting of leaves accompanies overwatering. **Phytophthora**, a fungus, often attacks the roots of overwatered trees causing similar symptoms.

Cupped, chlorotic leaves: Eriophyid mites. May also be 2, 4-D or Banvel-D injury.

Fireblight in apple, pear, hawthorn, mountain ash and others: Particularly severe in good flowering years and wet spring weather. New growth dies and turns black, starting with leaves and progressing down the twig into the branch.

Cytospora canker in poplars, mountain ash and birch: Canker usually obvious and almost always associated with other tree stress. Pinhead-sized black pustules appear on affected twigs, branches and trunk. In moist weather red, spiral, or clusters of spores appear on the bark.

Iron Chlorosis: Found in many species, but most common in soft maple, sycamore, some oaks and shrubs such as spirea growing close to foundations of buildings. Iron chlorosis cannot always be corrected by adding iron to soil because soil pH and other factors influence the problem. At best, most attempts to correct iron chlorosis are temporary.

After making a preliminary diagnosis, call a local specialist for confirmation and recommendations on appropriate control measures. It may be necessary to send a sample of the problem to a laboratory for analysis. When taking a sample follow their suggestions or use these guidelines:

a. Send a fresh sample; wrap in newspaper in a plastic bag for best results. Do not add water.

b. Collect diseased or injured parts as well as some healthy parts. Ideally, collect samples from the transition between diseased and healthy parts. Send more than you think will be needed.

c. Try to get a sample of the suspected cause as well as a sample of the symptoms. For example, nematode injury causes leaf symptoms, but the problem is below ground. A sample of soil is needed in this case.

d. Send along a statement of all you know about the possible causes and cultural history of the plant. Include name of plant, (scientific name whenever possible),age of plant, use of fertilizer, irrigation, soil type, exposure and other facts as listed above. Perhaps not all this information will be needed, but if you don't know the problem, you can't tell what information is needed. Send it all to be sure (Feucht, 1978). Include your name and phone number so that you can be contacted for additional information if necessary.

e. Time the sample collection and mailing so that the sample will be received on a weekday, to preserve sample freshness.

Control

Once a plant problem has been diagnosed, the next step may be to control it. Some pests cannot be controlled; others are not worthy of control. Because the types of chemical controls and techniques used in biological control change constantly, this manual will not discuss insect and disease control in detail; however, some general strategies will be presented. Consult a local specialist for further information.

Non-chemical control. Many infectious diseases and insect problems can be prevented and controlled without chemicals. A program of preventive maintenance provides very effective control of insects and disease:

1. Proper Cultural Practices

   Watering — avoid frequent, shallow waterings and foliar sprays in favor of adequate, deep irrigation. Do not over-water either.

   Wounds — prevent mechanical damage by sunscald, vehicles, lawnmowers, string trimmers, etc. Wounds provide an entry point for insects and disease organisms. Mulching the area three to five feet around the base of a tree with 3-4 inches of mulch can discourage weeds growing close to the tree and reduce the need for close mowing and trimming.

   General good health and vigor — healthy trees and shrubs are less vulnerable to attack.

2. Sanitation/Vector Control

   Some disease organisms and insects will overwinter or expand their numbers in debris or dead plant material. Eliminating such material near susceptible plants may reduce pest problems. For many pests, however, sanitation is of little value. Consult a specialist for information on a particular pest.

3. Resistant Species and Cultivars

   Before planting new trees or shrubs, check to see that the species is not inordinately subject to disease problems or insect infestations. Select species and cultivars resistant to prevalent pests.

4. Biological Control

   Biological control of insects involves the introduction of parasites, predators, and bacterial and viral organisms which attack the pest. It also includes the use of sterilizing agents and attractants or lures. Biological controls reduce chemical pesticide applications, use materials which are non-toxic to mammals, and affect only the target pest. With insect populations becoming resistant to chemical pesticides and the costs and regulations on the use of most commercial insecticides rising, a number of cities are initiating Integrated Pest Management (IPM) programs for city trees. An IPM program is based upon knowledge of the ecosystem of which the trees are a part. The IPM program explores all possible pest control options after evaluating the biology of the tree species involved, the life cycles of existing and potential pests, and the acceptable pest population and damage levels. It then determines what, if any, pest control measures will be most effective, striving to keep those measures as narrow and pest-specific as possible.

IPM can be used for pest problems on an individual tree or group of trees, but it is most effective for dealing with pests that threaten large areas or numbers of trees. It represents one of many management tools in urban forestry's efforts to look beyond individual tree care and manage the entire community forest as a whole. "In the three years Berkeley has had an IPM program, pesticide costs have dropped, regular calendar spraying of large numbers of trees has been eliminated, complaints from citizens have been reduced and an efficient organized approach to solving a complex management problem has evolved" (Olkowski et al., 1974).

As indicated above, there are a number of non-chemical control measures that effectively control insects and diseases. When discussing an insect or disease problem with an extension agent or qualified specialist, be sure to ask "What non-chemical control measures are available for this problem?" Non-chemical controls can be effective, safe and selective.

Chemical control. To use chemical controls properly requires an understanding of the life cycles of insects and diseases as well as a knowledge of the available commercial fungicides and insecticides, state and federal regulations for use; which chemicals are available on the market and how to apply them safely. Recommendations for specific chemical controls should be obtained from qualified individuals. State regulations may require that those who apply chemical controls be licensed. Pesticide applicator training and certification programs through State and Federal agencies are designed to insure the safe and appropriate use of pesticides. Some facts to keep in mind are:

1. Pesticide availability and use depends upon Environmental Protection Agency regulations and State licensing. Many chemical formulations are periodically withdrawn and/or reinstated for a particular use.

2. Toxicity of the chemicals varies; many pesticides (even those available to the general public at the garden shop or supermarket) are extremely poisonous. Safety precautions, including protective clothing and care in application are very important. There are prescribed procedures for disposal of excess chemicals and empty containers. Remember, the concentrate is the most dangerous form of the chemical. ALWAYS read and understand the entire label before using any chemical product. Follow directions for use explicitly. Using a chemical for any purpose or in any manner not specified on the label is illegal.

3. Timing of application must coincide with the vulnerability of the target pest to be effective. Your County Extension Agent will be familiar with the life-cycle of the pest species and its vulnerability to particular pesticides.

4. Insect populations may increase in their resistance to certain chemicals over time. Keep a record of past chemical control measures and seek the most current recommendations. When possible, alternate recommended chemicals to reduce development of resistance to any one specific chemical.

5. Specific recommendations may vary according to "micro-environment," local climate, etc. (Feucht, 1978).

Tree Removal

The safe and economical removal of dead or dying trees is one of many tree maintenance tasks that a community must anticipate as it embarks upon a community forestry program. Prompt removal of dead or dying trees will prevent personal injuries and property damage, and the often-associated lawsuits. The funding capabilities of your program will help to determine whether the community handles this task by itself or whether these services are contracted.

Removing major limbs, or an entire tree, is a dangerous operation under the best of circumstances. However, trained personnel, using the proper equipment and techniques, can accomplish the task safely. Employee and public safety mandates require that the community use fully qualified arborists to perform this type of work. Some communities employ such trained staff in-house, while others contract the work with commercial firms.

The following information is an overview of the important aspects of tree removal operations. It is derived from a slide-cassette program on the subject produced by the National Arborist Association. This overview does not represent a basis for training personnel in tree removal techniques.

The successful removal of a tree or part of a tree depends on several factors, the most important being tree location. If the tree is on a street relatively free of obstructions, such as

buildings or power lines, it may be possible to fell the whole tree in one piece. Difficulties increase when the tree is near one or more obstructions. When power lines are involved, the utility should be contacted and arrangements made for the lines to be de-energized or temporarily removed. In some cases, the utility may prefer to prune or remove the tree, to eliminate the hazard.

Large limbs allowed to fall freely to the ground can bounce and/or shatter. This endangers bystanders and arborist crew members, and can damage sidewalks, streets, landscaping and other property. Large limbs should be lowered slowly and safely by ropes to reduce these hazards. In more confined locations these limbs may have to be lowered and guided away from obstacles by an elaborate system of several ropes and the coordinated efforts of crew members in the tree and/or on the ground.

In complex situations an adequate tree removal crew may consist of three or more trained employees. Ground workers handle lowering and guide ropes while the arborists, secured in the tree or elevated by a mechanical lift place the ropes, tie the correct knots, and make the appropriate cuts.

There are several techniques available for dropping limbs in various situations. If the limb can be safely dropped directly to the ground, a jump cut can direct the branch to fall horizontally to the ground. Hinge cuts can be used to drop smaller branches and also to direct the brush end of a branch downward in order to avoid ground damage.

After the tree is cut to a stump, stump removal is best completed by using stump grinding equipment. This type of machine does not "remove" the stump, but grinds it down below the soil surface. Stump grinders are extremely dangerous and should only be operated by trained, competent workers. Manual removal of entire stumps is costly, extremely difficult and time consuming when stumps are large. Commercially available chemical stump removers work very slowly, if at all, and are not a viable option in community forestry.

Cleaning up is the final task. In most cases, debris and wood from a removed tree can be used as firewood, compost or mulch. However, if the wood is elm and the tree died from Dutch Elm Disease the wood must be debarked before use as firewood or buried in a land fill to prevent emergence of the beetle and spread of the disease. If the tree belonged to the city, wastewood and mulch can be sold to supplement the community forestry budget to help offset tree removal costs.

Whether tree maintenance crews are city employees or not is irrelevant to the need to establish and maintain the credibility of the community forestry program. The services of well-trained, well-equipped professional arborists who can remove trees safely is vital. State Forestry offices have literature and well as training films, and they frequently conduct workshops on tree maintenance and removal for city personnel. This is an excellent way of improving employee competence. Some cities, such as Boise, Idaho, require certification for private tree maintenance personnel to insure that tree removal will be done properly.

Tree removal is but one part of any sound community forest management program. That program also will include scheduled tree maintenance, which will reduce the number of necessary tree removals and expenses. Above all, remember that the best maintenance is preventative maintenance. Selecting pest-resistant trees suitable for the planting site AT MATURITY will reduce future maintenance costs more than any other function of the community forest management program.

Landscape Maintenance Schedule

Many maintenance operations may be required to properly care for the community forest. While all of these operations should be listed in the community's annual work plan, many communities, particularly those without a full-time person assigned to tree care, may find a calendar-based maintenance schedule useful. Figure 12-10 is an example of such a schedule. Modify the operations and times to meet your community's needs and environment.

Contracting

This chapter has discussed how to do the work, without yet mentioning who should do it. Should the community hire a professional arborist for its staff, or should it contract for arborist services? The answer is a firm, resounding "it depends"! How a community implements its tree maintenance program depends on many factors.

Perhaps the first question to ask is whether the community has sufficient tree work, year round, to occupy a full-time tree crew. Many smaller communities simply do not have enough tree work to justify employing an arborist and a laborer or two. These communities should contract their tree care.

When budgeting for tree care employees, all expenses must be included. In addition to salary

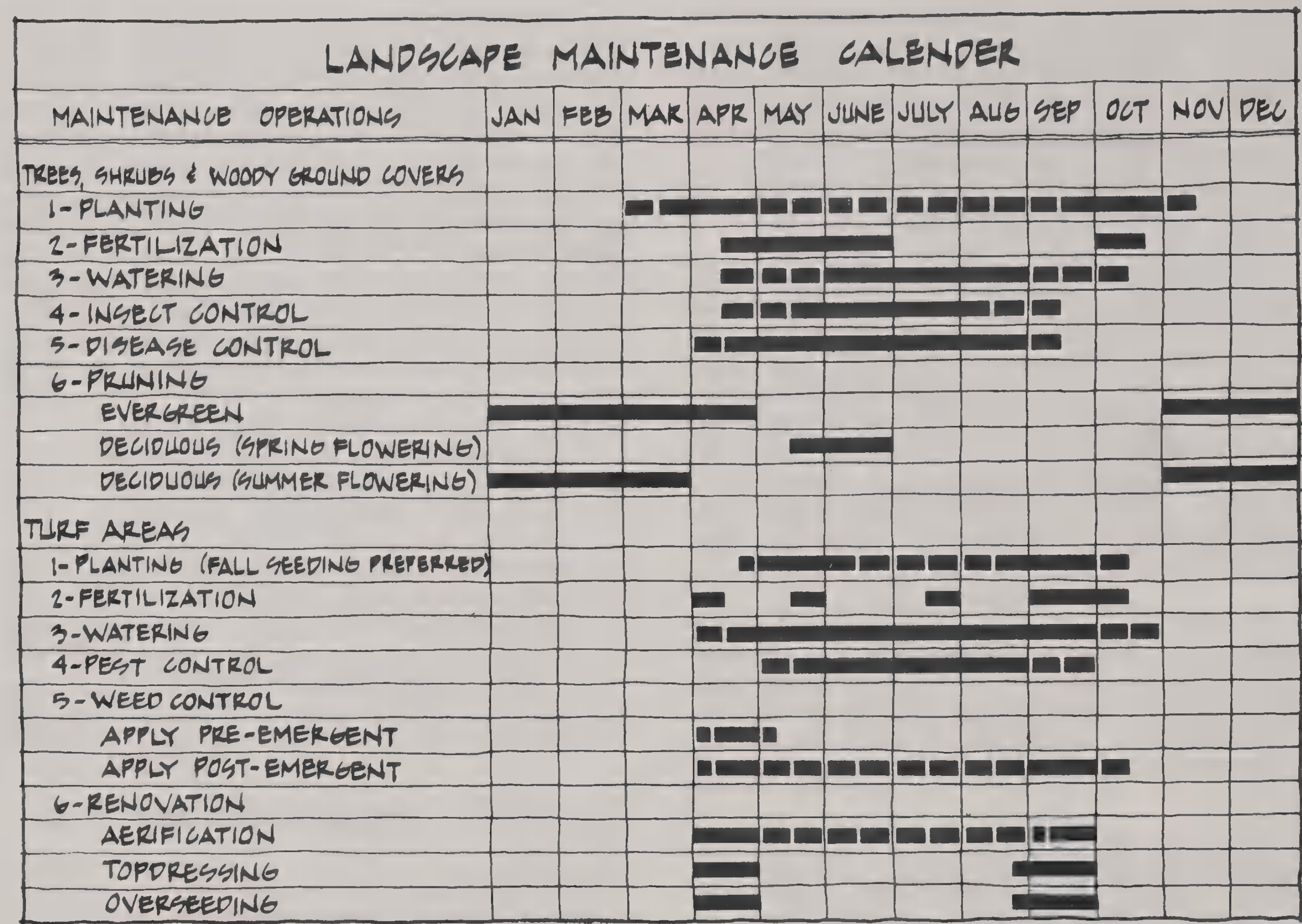

Figure 12-10. Landscape Maintenance Calendar

and benefits, the community must provide medical insurance, workman's compensation, and unemployment insurance. The community must also provide vehicles, tree trimming equipment and training for the tree care employees. These expenses, plus a profit, are included in contracts for tree care. However, an accurate comparison of costs may prove the contracted tree care to be a more economical option. The purpose of either in-house employees or outside contractors is to get the job done correctly at a fair and competitive price. Contracting may lower costs and provide an equal or better quality service (Tate 1987) depending again on the quantity of work needed to be done, year around. Contracting permits rapid shifts in work force size to respond to seasonal work loads and changing needs (anonymous 1988). However work performed by contractors may be very specific and inflexible to community needs, regarding emergencies or special circumstances. Scheduling conflicts with contractors can arise. Quality control on contract work must also be regularly monitored by the community.

Larger communities can often justify hiring one or several tree crews. Contract tree care can be used to supplement in-house crews if work backlogs develop. Some communities employ a city crew to respond to demand and emergency tree care needs and engage contractors to perform systematic tree maintenance.

One difficulty in contracting is estimating the potential cost of the contract. Many communities have the capability to track crew performance on tree care activities. This information can be used to estimate the man-hours required for a given job as a basis for estimating labor costs (Abbott and Miller 1987). Time to complete the task is obviously included in the estimate, but additional factors such as travel time, cleanup time, dump time, equipment maintenance and breakdown must also be considered. The article by Abbott and Miller provides several excellent examples from the perspective of the contractor, which the community forester can use to arrive at an estimate for proposed contract costs. Both Shriver (1987) and Cunningham (1987) require utility line clearance

contractors to report in 50 foot line units the number of trees trimmed, trees removed, area cut, and man-hours expended. This information is of great use in projecting needs in line clearing. The same concept could be applied to tree maintenance contract work.

The community forestry program can be divided into two functional areas: management and labor. In a small community, one person may serve in both roles. Other communities may hire a manager (forester) or a consultant to provide management, and the labor may be provided by municipal workers or contractors. In-house crews assure that there is a response to emergencies. Some communities promote competition between in-house crews and contractors, which keeps bid prices low and promotes efficiency within the in-house crews. A community must consider labor relations and unions when awarding to outside contractors work which is normally assigned to staff.

Contracting for tree care work requires skill and expertise. Somehow, in spite of best efforts, contracts often have loopholes. Learning from the contracting experience of other community foresters can be of great help. The state urban forestry coordinator may be able to provide sample bid specifications. Some communities maintain lists of qualified bidders. The recommendations of other communities about certain contractors can make the community aware of potential problems. Learn as much as you can about potential bidders to avoid "fly by night" operators who may be lowest bidder and also the poorest performer. Local Chambers of Commerce and Better Business Bureaus may provide useful information about the backgrounds of potential contractors. It is also wise to ask for and check up on references where work was previously performed.

Bid Specification Preparation

Writing bid specifications should involve the community's tree care manager, purchasing agent and attorney. To quote Page (1985), "the purpose of a contract is to get a qualified contractor to do the work at the lowest price." We would add, quality work at the lowest price. Bidding procedures and requirements must be clearly stated, including the deadline for receiving bids, the date, time, and place of bid opening, required bid, labor and material, and performance bonds, certification for workman's compensation, general liability, and accident insurance coverage, references, etc. Then the exact type and amount of work must be specified.

Three methods are commonly used for pricing tree care work: unit price, time and materials, and lump sum bidding. Unit pricing is based upon a price per unit of work performed, and is very useful when the total quantity of work is not known. For example, elms infected with Dutch Elm Disease must be removed within 21 days to prevent bark beetle dispersal from the infected trees. This tight time frame can be accommodated by pricing tree removal on a unit basis, usually based on 2 to 6 inch diameter classes, and by selecting the contractor prior to the growing season. Then the community forester need only report the location of the problem tree to the accepted contractor, who then does the work promptly, per the contractual specifications. Unit pricing is useful in controlling costs for tree work when the quantity of work is an unknown and when budgets are limited.

With time and materials pricing, work is bid based on hourly rates for different classes of labor and pieces of equipment. This type of pricing works best when specifications are not clear, work quantities are not known, and time is not available to get this information. Time and materials pricing is often used to contract for emergency work, for example after a severe storm. Only good supervision by the person in charge of tree care will assure that work done under a time and materials contract is worth what it costs. Monitoring contractor activities prevents inaccurate billings for services. However, crew productivity remains a problem with this pricing method. Crews are paid by the hour, not the quality or quanity of work completed. Because of these problems, time and materials pricing is not recommended for routine, programmed tree maintenance.

Lump sum bidding involves obtaining a price for an entire job. This is best used where budgets are limited and the exact quantity of work is known. Tree planting, trimming, stump removal, and removal of hazardous trees can be effectively accomplished using lump sum bids.

Bid specifications must indicate how to bid for the services to be provided. Bids may take the form of a price per tree diameter class, price per linear mile of street, price per hour for labor and equipment, or price for a total job. When using unit pricing, if approximate quantities of work are known, indicate them in the bid specifications, stating that the figures are only estimates and are not binding. If no estimates are available, consider using the amount of work done in the previous year to give the contractor an idea of the quantity of work. Clearly state on what basis the award will be made, that is, how the bottom line will be determined. With lump sum bids, this is clear, but there can be confusion with unit pricing and time and materials bids. When reviewing submitted bids, the community can apply bid quotes to the estimated quantities of work to extrapolate a bottom line cost figure of the contract.

Include a starting date for work to begin as well as a completion date (Page, 1985). Consider specifying checkpoints, that is a set percentage of the work that must be done by certain times during the contract period. Work with the contractor to allow work to be grouped. Do not require stump removal immediately. Some contractors will subcontract stump removal, and will want a number of stumps to get a better price, or at least to provide for a full day's stump grinding.

Arborist and Tree Worker Contract Requirements

Many communities use a bid security, often in the amount of 10% of the amount bid, to insure that only sincere contractors submit bids. If the bidder fails to sign the contract, the bid security is forfeited. Similarly, a performance bond should be required to protect the community, after the contract is signed, from a contractor who does an incomplete or unsatisfactory job. The bond, in the amount of the contract price, can be used by the community to complete the contract work, or to repair damages. A contractor should always be required to prove sufficient insurance coverage.

The bid specification should require that any successful bidder possess a current business license. If the community, state or other entity certifies or licenses arborists, this should be a specified bidder requirement also. For example, the International Society of Arboriculture (ISA) and the states of Kansas, Nebraska and South Dakota have voluntary certification programs. Lilly (1989) discusses procedures and caveats in developing a certification program. Additional information on certification is available in Appendix G.

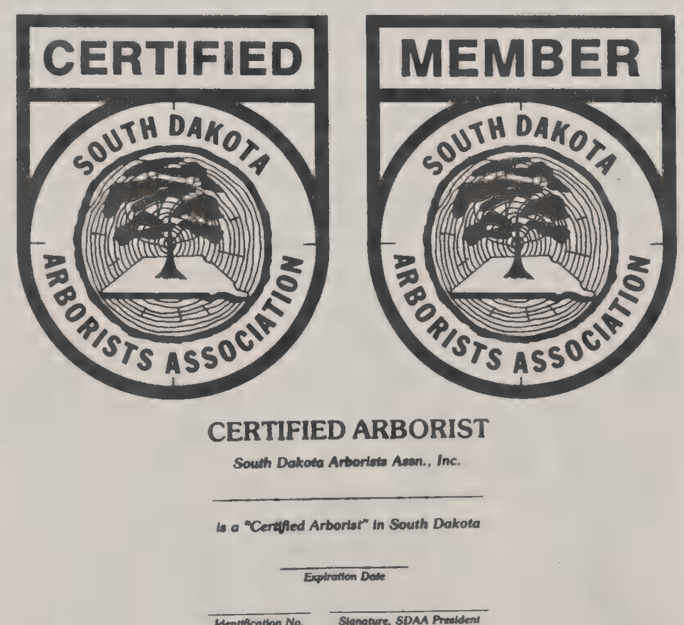

Figure 12-11. Arborists and Tree Workers Who Certify and Associate are Skilled Professionals

Each bid specification and contract should include penalties for failure to perform satisfactory work, clauses delineating how to terminate the contract for non-compliance, "to hold harmless clauses", and incentives for completing quality work on time. The relationship between a community and a good contractor should be cultivated. Recognize that work may be delayed by equipment breakdowns and other unforeseeable circumstances. Try to understand the contractor, and his problems. Simply because the contract specifies that the contractor may be penalized for a delay does not mean that he must be. A good contractor should be rewarded for doing good work. Some communities award contractors a bonus of 1% to 5%, for timely completion of satisfactory work. Wallace (1988) reports success with an incentive type contract based on crew performance. Forty percent of the bonus is paid to production people, and the rest split between contractor and non-performance people. Consider the option to extend the contract without competitive bids as another reward. To avoid misunderstandings, be certain to state explicitly what must be done to achieve the bonus. Page (1985) gives an excellent discussion of contracting for tree planting. Other suggestions are listed at the end of this chapter.

Bid specifications may be written so loosely that poor quality work meets contract specifications, or they may be written so restrictively that no one will bid on the contract. Poorly written bid specifications can increase bid prices, decrease competition, and be confusing (Tate 1987). Both the community and the contractor "must have a specification in which the scope of work is clearly and concisely defined" (Cunningham 1987). Consider using standards developed by the National Arborists Association to specify tree maintenance work. Contracting should be a win-win situation. The community should receive quality work, and the contractor should make an honest profit. This mutualistic relationship is the only way that a community can expect to obtain long term, high quality contract tree care.

Advertisement of Request for Bids

Once bid specifications are prepared, a request for bids is advertised in the community's official newspaper. This is a legal requirement. When was the last time you read the legal notices of your community? Tree care contractors don't always read it either. This part of the process is called advertising for bids. ADVERTISE! Determine who the potential competitive bidders are: call other cities and local tree firms. Send bid specifications to them. Call them if you don't get a sufficient response. Be sure to mention the pre-bid meeting (see below). Advertise as early as

possible to give contractors time to review work, and to get the work started on time.

Pre-bid Meeting

A prebid meeting provides an opportunity for contractors and community representatives to discuss work to be done and avoid misunderstandings. Read through each section of the specifications so that contractors hear what the specifications say. Consider showing bidders acceptable work, such as a properly pruned tree.

Contractors well informed about the job will be more competitive in their bids and will do a better job. Only contractors who attend a pre-bid meeting should be eligible for bid invitations. This requirement may be difficult to enforce, but it helps foster better communication between the community and prospective bidders.

Awarding the Contract

Carefully examine the low bid to determine if the bidder is responsive to the specifications and has the equipment and crews capable of completing the job. Cunningham (1987) weighted bids based 70% on lowest price and 30% on technical evaluation. Shriver (1987) permits a successful bidder to verify the accuracy of a bid that is more than 25% below the next lowest bid. The bid may be withdrawn by the contractor, or he may accept the job at the quoted price. This protects the bidder from having to accept a job for an erroneous bid price.

The process does not stop after the contract is awarded. Successful contracting requires supervision of the contractor, feedback to him, and modification of future contract specifications. Monitoring contractor performance is one of the most critical parts of the contracting process (Tate 1987). Have well trained and available supervision, be willing to understand the contractor's point of view, and give the contractor a chance to correct deficiencies. Tate (1987) suggests that a written assessment of the contractor's performance be prepared upon completion of the contract and shared with the contractor so that he may learn from the experience.

Additional Points for Bid Specifications

Below are some potentially useful ideas to consider for inclusion in tree maintenance bid specifications:

1. Require all of the contractors vehicles to display the contractor's name and phone number on the side of each vehicle in legible lettering. This can help the public to identify the contractor and discuss problems. In addition, a professional contractor will want his name in the public view.

2. All costs incurred in the performance of the contract are the contractor's responsibility (Page 1985).

3. Contractor is responsible for all safety conditions involved on the job (Page 1985). He must post streets if he wants to close a lane of street, and must comply with city, county and state rules when working on roads under each jurisdiction.

4. Contractor is responsible for locating and notifying all utilities of work to be done, where, when and if schedules change. This is extremely important because if the community takes on this responsibility, it must coordinate schedules with the contractor and the utility, and it is often caught in the middle.

5. Limit work hours to between 7:00 a.m. and 6:00 p.m. This will greatly reduce resident complaints about noise.

6. Contractors are responsible for restoring the work area to its pre-work condition. This includes raking twigs and leaves, placing soil and grass seed over ground-out stumps, and repairing any turf, sprinkler system, shrubbery, or pavement damage.

7. The contractor must obtain any necessary permits required by state, county or municipality.

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XIII. CASE STUDY

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CASE STUDY
GROVE CITY, NEBRASKA
(POP. 2000)

To illustrate how the process in this manual is applied, we have developed a case study. Although the case study is hypothetical, much of the basis for the story has been drawn from observations made in Wellsville, Utah, during a trial application of the urban forest planning process.

Grove City, Nebraska

Our imaginary community of Grove City, Nebraska, could be located almost anywhere in the Interior West. At a recent meeting of the Beautification Committee, several committee members expressed a number of concerns over the condition of trees on publicly owned land in Grove City. They noted the following:

1. A number of topped trees along Main Street were dying and needed to be removed and replaced. Several were lifting and cracking the sidewalk.
2. Numerous dead branches in trees throughout the town were in need of immediate attention.
3. Several new subdivisions had been built over the past few years, and not a single tree had been planted in the planting strips.
4. The town park was virtually treeless; unused benches and picnic tables baked in the summer sun.
5. A number of trees were diseased and several were prone to leaf defoliation each summer.

In general, the Beautification Committee felt that something needed to be done to stop the deteriorating town image. The committee decided to approach the mayor and town council to express their concerns and to find out who was responsible for tree care in Grove City.

Melva Elm, a life-long committee member, volunteered to attend the next council meeting and make a presentation. After Melva's presentation the mayor responded by stating quite frankly that he didn't know for sure who was responsible for care of the trees; the council wasn't sure either but remembered that parks Director, Brad Oaks, had been asked to prune some trees at one of the neighborhood parks. All, however, agreed that something ought to be done and recommended that Brad and Melva get together to discuss the situation. The mayor then recalled receiving some sort of publication about Community Forestry or something like that. He went to his office and returned with a copy of the *Urban and Community Forestry — A Guide for the Interior Western United States* **(the manual)** and recommended that the committee read it and report back.

After reading the first four chapters the committee made several interesting discoveries.

1. Tree planting in the west is a tradition that dates back to the first white settlers.
2. Trees aren't just elements to beautify a community; they are also valuable for a number of functional and ecological reasons.
3. Tree planting and management programs are possible in any size community and are frequently initiated and administered by lay-citizen groups through Shade Tree Commissions.
4. The main ingredients in a successful community tree program are interest, enthusiasm and a long-term commitment.
5. Technical assistance for community forest inventory and planning are available from the State Forestry Agencies to help communities initiate programs.
6. Tree programs are best administered by a professional urban forester if finances are available for such a position. If finances are limited, the Shade Tree Commission needs to work closely with the person responsible for tree care.
7. It is necessary to raise funds for tree care beyond monies available from the general fund.
8. Volunteers and activists can make a difference.
9. Others throughout the nation are concerned about properly managing and improving our community forest resource.

These discoveries reinforced the committee's commitment to continue their efforts.

At the next council meeting, the Beautification Committee recommended to the Mayor that a Shade Tree Commission of five members serving staggered terms be appointed to work with tree care manager, Brad Oaks. As suggested in the manual, the committee proposed that the Commission be given legal status and be advisory to the mayor and council. They also suggested that the Commission's responsibilities include:

1. Needs assessment
2. Goal and policy setting
3. Program implementation and promotion

After a thorough review, the Beautification Committee's proposal was given unanimous approval by the council. The Shade Tree Commission was born! The mayor appointed five local citizens to the Commission. Three were members of the Beautification Committee, one was a businessman and another was an orchard manager. The city engineering consultant and Brad Oaks were asked to serve as ex-officio members.

The members decided to schedule monthly meetings and began working immediately. They assigned themselves the task of reading sections of **The Manual** and then developing a prioritized list of tasks to be accomplished.

After reading The Manual they all agreed that their first undertaking should be the establishment of general **goals and objectives** for the Grove City Community Forest. The goals they established were:

Goals:

1. The re-creation of the Grove City image as a community of trees.

2. The development of a community forest that would be low in maintenance and water requirements.

3. The development of a forest plan that would maximize the benefits of tree planting.

Objectives:

1. Assessment of existing tree care activities.

2. Maintenance of community-owned trees to insure public safety and tree longevity.

3. Annual replacement planting within the existing community.

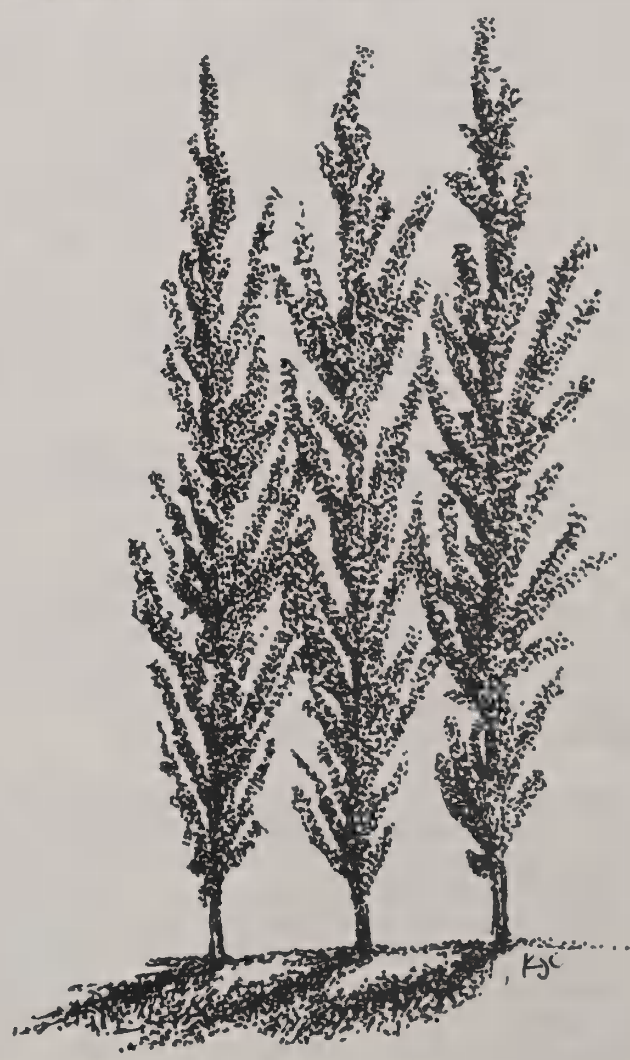
4. Required planting for all new development.

5. Selection of trees which tolerate drought and have low maintenance requirements.

6. The development of both a promotional and funding campaign that would annually support progress toward the stated goals.

During the July meeting, the Shade Tree Commission discussed the relationship between their goals and objectives and the **Community Pattern Inventory** and the **Tree Inventory.** After reviewing the manual they realized the importance of these inventories and decided to devote the next several meetings to completing them. They also decided to recruit more volunteers to assist them.

Before the next meeting, the Commission members gathered five maps of Grove City from the consulting city engineer. These base maps showed all the roads, blocks, lots and public buildings. Using The Manual as a guide, they were ready to map the community pattern. They felt confident they could do all the necessary mapping right in the meeting hall.



They began by discussing landscape character, jotting down character elements that were important to all of them. The list included:

1. The oasis-like quality of Grove City, a concentration of trees surrounded by fields, bounded by low grassy hills.

2. The importance of windbreaks and hedgerows of trees that visually linked Grove City with the agricultural area adjacent to town.

3. The importance of the creek as a distinct form that contrasted with the geometric pattern of streets and fields.

The commission secretary took notes during the discussion and later typed them. These notes would be essential as a reference when the time came to develop the forest plan.

The Commission members then divided themselves into three groups, each with maps and a handful of colored pencils. One group volunteered to map the **significant landscape features** in Grove City. They used red circles to identify **special places** including the school, the park and two churches. They used green pencils and sketched in all the **existing tree masses** they could recall. They drew brown lines to identify all areas of **steep topography**, **wildlife habitats**, and **riparian corridors**, including the **canal** and **creek.** They identified the **best views** from Grove City streets, marked them with arrows and described the view.

The team assigned to map **land use** had an easy task since there weren't many different land uses in Grove City. Using a red pencil they shaded in the commercial block; with yellow they colored in all the residential areas. They used blue for the school and park, gray for the churches and purple for the only industry in Grove City, the dairy co-op.

Street patterns and the relative importance of streets were the mapping responsibility of the third group. The **street pattern** was clearly shown on the base map, so coloring it was unnecessary except to note the curving road design of the new subdivisions. The group used heavy black lines to identify Main Street and Center Street as the most important streets in Grove City. With a thin, solid red line, they recorded as many of the overhead **utility lines** as they could recall and marked narrow **planting strips** (those less than four feet wide) with red stars. Narrow strips occurred in several locations around town. The group felt that a field check of the overhead utility locations and planting strip widths would be necessary to confirm the accuracy of their map and to fill in details that may have been omitted.

After finishing the three separate maps, the Commission reassembled and prepared a **composite map,** using the manual as a guide. When the composite was completed, the Commission was surprised at how clearly the physical structure of Grove City was reflected in their Community Pattern Composite Map as shown in Figure 13-1.

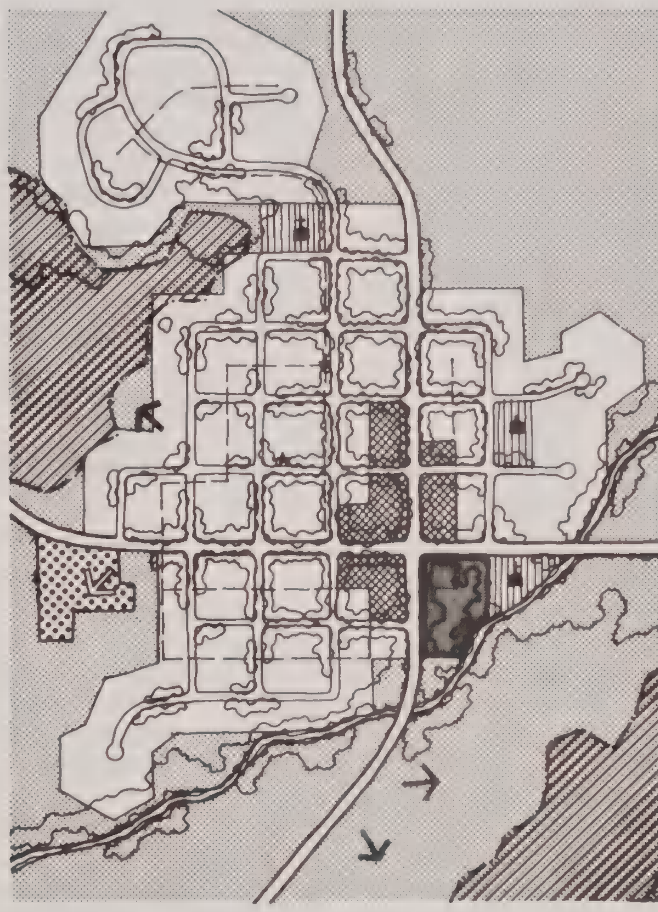


Figure 13-1. Community Pattern Composite Map

The Commission's next major undertaking was the **Tree Inventory.** They decided that their immediate objectives were to identify hazardous conditions, to determine the maintenance needs, and to estimate species composition. They agreed that this could be accomplished easily by driving the city streets and having observers record the information of interest. There was some disagreement about whether to do a complete inventory of Grove City or to do a sample of the city. It was decided that they would devote one full day to the inventory, thus letting time determine the extent of the inventory. Melva, apparently becoming the Commission's "public relations specialist," promised to get an article about the inventory into next week's newspaper.

Before beginning the survey, they contacted the State Forestry Representative for their district, who came and gave a short presentation on vegetation inventories and on hazard tree detection. A local tree service also agreed to teach them about tree maintenance and tree species recognition.

On the day of the inventory the Commission secretary made four copies of inventory instructions and 50 tally sheets. They divided the town into four sections and assigned a car to each one with three people in each car. Each crew was given a tree identification book to help them with unknown trees. The driver was responsible for noting overhead wires; the other two people were recorders. The recorders filled out additional information on the tally sheets, including species, trunk diameter, and condition. They recorded the street addresses of trees that seemed hazardous.

Within three hours the job was done. Information from the tally sheets concerning utility lines and planting-strip widths was transcribed into the Community Pattern Map. Data from the tally sheets were summarized to determine maintenance needs and to estimate the value of the existing forest because this information would be useful in prioritizing future projects. Melva wrote up a short article about the inventory for the weekly paper.

A few weeks later, several members of the Commission attended a workshop on tree care co-sponsored by the Cooperative Extension Service and by the International Society of Arboriculture. Although many of the topics were technical and not of direct use, members came away with a better understanding of trees. Brad Oaks felt much more confident about doing his job properly. He gave thought to further training in tree care work. Brad found that the State Arborist Association with the state forestry agency trains and certifies arborists and tree workers each fall. All were impressed by the tremendous technical knowledge available to them. They met many enthusiastic, knowledgeable tree people, many who offered to help Grove City improve its Community Forestry program. All the members who attended agreed it was a worthwhile program, and they proposed to the full Commission that the Commission sponsor a membership in the International Society of Arboriculture, and that at least one member attend each future workshop. The Commission agreed and approached the mayor for the funds.

The excitement level at the November Commission meeting was high. Their homework was done and now it was time to put together the **Community Forest Plan Map.** All the members had reread the manual section on the Forest Plan and were anxious to get started.

They got out the Community Pattern Inventory and discussed at length its implications for the planting concept, tree size and character and the concerns of the Forest Plan. As the manual suggested, they felt they must decide on a planting concept first. After a heated discussion, Commission members agreed that a **formal planting concept** was right for Grove City with modifications where necessary to accommodate unique situations. Formal planting would compliment the grid pattern of streets and would be suited to the numerous narrow planting areas. They recommended informal planting arrangement for the new subdivisions built in the bur oak forest at the edge of town, for the area around the industrial complex, and for the school and park. Combination planting patterns were recommended where formal plantings crossed the existing riparian plant community. The vote on **tree size** went in favor of medium-sized trees for all side streets and large tree species for Main and Center in the Grove City pattern. The Commission recommended small trees for side streets with overhead utility lines. Mixed tree sizes were proposed for the new subdivision, school and park.

The Commission also agreed that trees with formal or semi-formal **character** would best compliment the agreed upon formal design concept. Trees with semi-formal or informal character were only recommended for the park, industrial complex, the new subdivision, and the combination plantings. A windbreak, woodlot, and municipal tree nursery were also proposed.

Melva kept notes of the discussion and of the decisions made. She volunteered to type up her notes in report form as suggested in The Manual.

After the discussion ended, the Commission members began drawing up their recommendations on a base map. They identified areas scheduled for formal planting with a solid band of green. They used an irregular band of green to show areas to be planted informally and a broken outline to mark areas for combination plantings. Vertical cross-hatching drawn over the green color along Main and Center streets indicated areas for large trees. Horizontal cross-hatching identified where medium-sized trees would be planted. Stippling indicated small tree planting and cross-hatching identified mixed tree sizes.

The next step was to identify the Tree-Type Categories shown on the Forest Plan Map and prepare a list of acceptable trees for each category. They reviewed the plan, settled on four planting patterns, specified four tree sizes, and proposed the windbreak. This resulted in eight Tree-Type Categories: formal large, formal medium, formal small, informal large, informal

mixed, combination mixed, wildlife, and the windbreak.

Using the process described in the Plant Selection chapter, they listed all the appropriate trees for each Tree-Type Category. They then went back to the inventory data and determined the species composition of the existing forest. To promote species diversity, species which represented more than ten percent of the existing tree population were placed in a category entitled "deferred use." The other species were categorized as "liberal use." The orchard grower wanted to try a few species which he was sure would do well. These were listed as "candidate use" trees. When completed, the list was printed in the legend of the Forest Plan Map. The completed drawing was tacked up next to the Community Pattern Inventory as shown in Figure 13-2. The Board members were pleasantly surprised. The **Community Forest Plan Map did, in fact, reinforce community pattern!** They'd done it! The map and Melva's report completed the Forest Plan. The meeting adjourned to the Grove City Mercantile for a celebration.

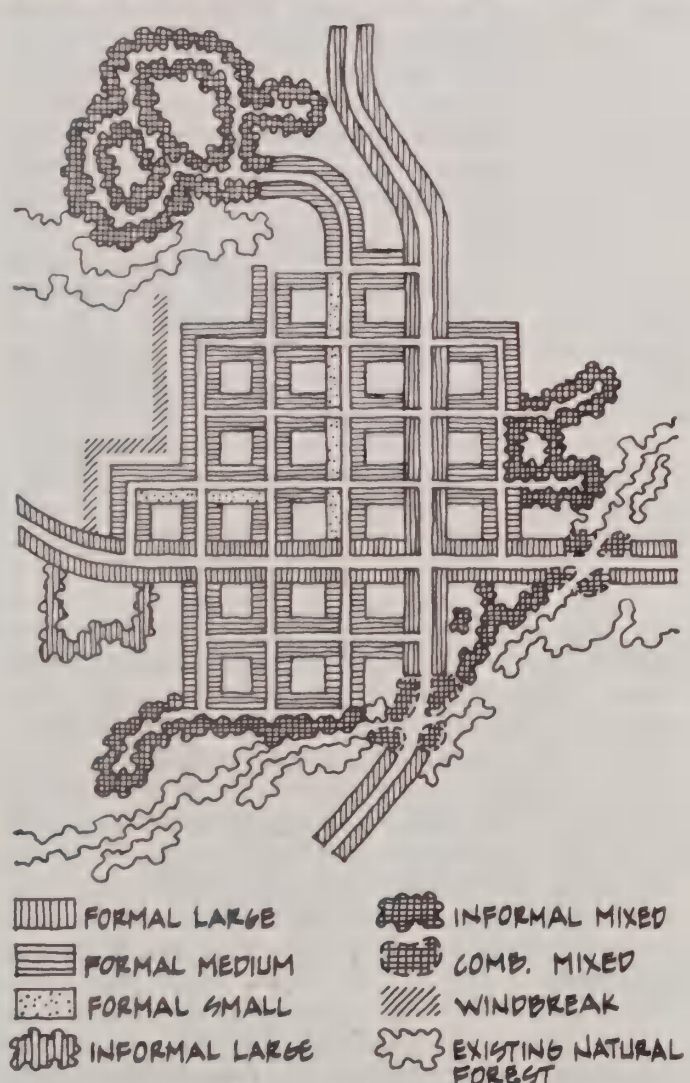


Figure 13-2. Community Forest Plan Map

The following week the mayor scheduled a **public hearing** for purposes of reviewing the Forest Plan Map. The chairman of the Shade Tree Commission presented the plan to the council and the 30 people in attendance. After some discussion about the merits of the plan and the probable cost, the Council approved it unanimously. At the same meeting the idea of a street tree ordinance was also discussed. Sentiment ran very high against "more damn governmental regulations," and with no city employee specifically charged to enforce an ordinance, the idea was dropped. Tree advisory members agreed to consider a permit system. They subsequently did develop a permit approach to regulation, requiring that a permit be obtained for tree planting, removal or maintenance on public land. They pointed out that a permit system could work only if the public was regularly informed of the benefits of the urban forestry program. The city council charged the Tree Commission with promoting the program and approved the recommendation for the permit system.

They proposed that permits be applied for at least five days before doing the proposed work. Permits could be obtained from any Tree Commission member or from the receptionist at the Grove City town hall. Permits obtained at the town hall would have to be approved by a member of the Shade Tree Commission. There was considerable discussion about how to deal with work done without a permit. They decided to try the permit program and determine afterwards the extent of the problem.

The Commission spent one meeting discussing a brochure on the Tree City USA program that was given them by the State Forestry Department. The brochure listed the criteria necessary to qualify for Tree City USA. Much to their surprise the Commission discovered that their community forestry program met all the criteria for recognition except the two dollar per capita funding for Community Forestry and the Arbor Day Proclamation.

Funding was a problem, and the Commission agreed they'd better face it now. They developed, after a lengthy discussion, a funding strategy which had several approaches:

1. They would seek funding from the Grove City capital improvement budget. This money would be earmarked for annual tree maintenance because public safety was involved.

2. They would organize a community canvass combined with a promotional effort to solicit funds for new and replacement planting.

3. The orchard operator suggested that they try selling Christmas trees and use the profits for purchasing new trees.

4. They would propose an amendment to the subdivision ordinance requiring an additional $30 fee for each lot. The money collected would be used for purchasing and planting trees in the development.

5. They would utilize as fully as possible in-kind services and donations from local citizens and groups to complete planting projects. The Dairy and Mercantile were identified as potential funding sources.

Several Commission members said they felt soliciting funds was a waste of time unless it was coordinated with a promotional campaign. This comment generated some imaginative ideas, five of which were ultimately agreed upon.

1. The Commission would publish an annual report in newspaper format and distribute it to each home. The paper would include a statement of goals, an updated value for the community forest, photographs of the Pattern Inventory and Community Forest Plan, and photographs and descriptions of completed projects. They planned to include a feature article by the State Urban Forestry Coordinator and also articles by local residents on landscaping tips. The report would also include tree lists and other useful pieces of information from **The Manual.**

2. Commission members would accept invitations to discuss the program at meetings of such community service groups as the scouts, 4-H groups, and Rotary. They also agreed to put together a slide presentation to give annually at the school.

3. The Commission set a goal of having an article about some aspect of the Community Forestry program in the weekly newspaper at least every other month.

4. The Commission began planning to organize Arbor Day activities into a Grove City community celebration, an annual event that would involve all residents.

5. Tree City USA recognition, a goal set by the Commission, was to be achieved within two years.

They knew they had carved out a sizeable task for themselves, but they also knew how central it was to making the Community Forestry program become a reality.

With the Community Forest Plan and Permit System approved, the Shade Tree Commission channeled its energies into the difficult task of determining **project priorities.** The Commission's review of the Tree Inventory clearly indicated that the existing community forest needed maintenance attention. Although the committee was anxious to begin several new projects, they all agreed that removing dangerous limbs, dead and diseased trees must be the first priority.

The Shade Tree Commission outlined these critical maintenance needs in a letter and forwarded it to the mayor. The mayor agreed with their concerns for public safety and committed town funds to have a qualified arborist begin the maintenance program. They thought it wise to accept bids only from those arborists who had completed the State sponsored arborist certification course and had a specified level of liability insurance coverage.

The Commission gave second priority to a replacement planting project for a two-block section of Main Street. This section was selected because only four Norway maples remained from the original planting and this section of Grove City had a high degree of visual significance to all community residents. The Commission felt that a successful planting in this two-block section would do more to promote Community Forestry in Grove City than any other site they could choose.

The Shade Tree Commission spent an entire Saturday in March doing a detailed **Project Site Evaluation.** The purpose of the evaluation was to gather specific information about the project site that would help them select the most suitable tree species. They reviewed the Project Site Evaluation section of The Manual and followed its instructions for gathering information about the visual, spatial, physical, biological and functional features of the site.

The **visual and spatial** characteristics of the site and its personality were recorded with photographs. The Commission discussed the visual importance of the simply detailed, but interesting buff brick buildings in the commercial block. They were also impressed by the neat white clapboard homes in the residential block. They noted the curb-to-store-front concrete paving in the commercial area and the 8-foot planting strip and walk configuration of the residential area. They took photographs of the attractive street light fixtures. They found no overhead wires on the project site.

At a later Commission meeting, members discussed the findings of the visual and spatial evaluation. They began by reviewing the Community Forest Plan Map recommendations for

the project site. The rest of the discussion centered around defining appropriate plant forms, seasonal colors and textures.

After reviewing the guidelines in the manual on visual and spatial criteria for tree selection, the Commission came to a consensus that the following plant characteristics were desired for the Main Street project:

Formal Large Tree-Type Category (as specified on the Forest Plan Map)

Seasonal colors
- Light green — spring
- Green — summer
- Yellow — fall
- Dark Brown — winter

Medium texture in all seasons.

As part of the **physical and biological** evaluation, the Commission members measured out walk and planting strip widths and recorded their findings. They took soil samples from four different locations in the residential block and sent the samples to the State Extension Service for analysis. Later test results indicated the soil was suitable for tree planting although deficient in iron and phosphate, subject to compaction, and slightly alkaline with a pH of 7.2. Road deicing salts would be an additional problem to overcome. No soil tests were taken in the commercial block because planting sites would have to be cut out of the pavement and new soil brought in.

Because of the limited rainfall in Grove City, it was evident that an irrigation system would be needed. They agreed that drip irrigation was the best system to use and that drought-tolerant tree species were most appropriate. None of the other potentially limiting physical and biological factors listed in the manual were discovered on this particular project site.

The Commission summarized its findings for physical and biological criteria for tree selection as:

- Tolerant of alkaline soils
- Tolerant of deicing salts
- Tolerant of soil compaction
- Tolerant of drought

The Shade Tree Commission reviewed the manual section on **functional evaluations** and determined that the major **functional** contribution that trees could make on the project site was climate control, especially in the commercial block. Shade for pedestrians and parked cars would make shopping in downtown Grove City a much more enjoyable experience. Planting for climate control would also make the environment in the residential block more pleasant. Because the buildings in both blocks were small and the sidewalks wide, the commission decided that a broad spreading tree which casts moderate shade would be desirable. Other functional concerns—such as screening, traffic control, and erosion control—were not of major consequence.

Planting and maintenance concerns, however, came up for considerable discussion by Commission members, particularly in relation to the commercial block. It was evident that spaces for tree planting would have to be cut out of the existing concrete walk, a drip irrigation system installed, and planting pits prepared with good quality topsoil. Because of the high initial cost and potentially difficult and expensive task of replacing trees in the commercial block, the Commission felt that the tree species selected for planting must be extremely hardy, drought tolerant, long-lived, and clean.

Since vandalism in Grove City was minimal, the Commission members agreed that 1 " to 2" caliper trees would be adequate. Selecting trees of this size rather than larger, more expensive and vandal-resistant trees would reduce costs. By using smaller caliper trees, the Commission felt it could plant an entire two-block project site and remain within the budget.

The Commission summarized its review of the functional criteria for tree selection as follows:

- Moderate shade
- Hardy
- Clean
- Long lived
- 1 1/2" to 2" caliper

During its March meeting the Shade Tree Commission devoted the entire session to selecting a tree species that would meet all the criteria specified both in the Forest Plan and the Project Site Evaluation. They copied all the trees listed in the Formal Large Tree-Type Category then used the Tree Selection Matrix in **The Manual**. The two trees which met all the primary criteria and secondary criteria were the Norway maple and the Littleleaf linden. Norway maple was tentatively selected for the project site because after reviewing the tree inventory, they found that Norway maples constituted only seven percent of the present community forest. Also, the Norway maple was the more drought tolerant of the two and could be sustained by a drip irrigation system. During the next week Commission members called on all the business owners and residents in the project site area. They explained why Norway maples were chosen and asked them if they had objections to their choice. Since well over 80 percent of those called supported the committee's

choice, they decided that Norway maples would be the tree to plant.

At the April meeting a planting plan was drawn showing the exact location of each tree to be planted. Melva's son Bill, a landscape architecture student, helped draft the plan. The plan had the formal appearance specified in the Forest Plan: 16 trees on each side of the street beginning 40 feet from each corner, spaced on center at 28-foot intervals, and set in 4 feet from the curb. The only block that differed was the one with the four existing maples. Melva sent a copy of the plan to the newspaper.

The following week two Commission members spent two hours staking the design out on the project site, using a tape measure, a bundle of stakes and a red grease pencil. The stakes were used to mark tree locations in the residential block, the grease pencil to mark planting places on the sidewalk of the commercial block.

A local firm was contracted to cut the planting pits out of the sidewalk and install the irrigation system in the commercial block. The Grove City Lions Club agreed to prepare the soil and dig all 60 planting pits as a public service project.

A deadline for completion of the preparation for planting was set for the second week in April so that everything would be ready for planting on Arbor Day.

Several nurseries in the region were phoned and asked for price quotes on 60, 1 1/2" to 2" caliper, balled and burlapped Norway Maples delivered to Grove City. After reviewing the bids, the Board members visited the two low bidders and examined their nursery stock. They placed an order at the nursery with the best trees, although its bid was slightly higher.

Plans for the Arbor Day celebration and work bee were made. The mayor and council agreed to be on hand to plant the first trees. The Grove City Explorer Scout Post volunteered to help with the rest of the planting. A local utility company agreed to provide a truck and crew to move trees from the delivery site and to haul backfill. A Commission member was assigned to each block to supervise the planting.

Figure 13-3. We Did Not Inherit the Community Forest From Our Fathers, We Are Borrowing It From Our Children

Planting instructions were drawn up and given to the scout master to review with his troop. Local church groups planned to prepare and serve a lunch for all the workers. Regional newspaper, radio and television personnel had been contacted to cover the event.

The trees, which arrived the day before Arbor Day, were inspected by the orchard owner. He found the trees healthy, and without broken branches, bark damage, girdled roots or cracked root balls. The trees were accepted, paid for, and stockpiled, covered with wet burlap bags to prevent drying. Everything was set for the big day.

Arbor Day was bright and beautiful. The mayor read the Arbor Day Proclamation and the elementary school kids sang "America the Beautiful." The planting went off without a hitch. The trees were planted at the proper depth, backfilled with native topsoil and watered as specified in the manual. Oh, the mayor did get dowsed with water by several overzealous scouts, but he took it well.

Almost everybody in town turned out either to watch or to participate in the festivities. Some of the older residents, including Melva, said the occasion was one of the more memorable ones in recent Grove City history. A number of Board members were approached by residents asking if next year's project couldn't include their block.

The End . . . ?

No, a Community Forestry Program really has no end. If it is to succeed it must be seen as an ongoing process, a process of continuous renewal and maintenance. It will require the continued commitment of Grove City citizens, of the Shade Tree Commission, and of the elected officials of this generation and those of the future. **Urban and Community Forestry — A Guide for the Interior Western United States** can be used as a resource manual as the process continues.

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APPENDICES

A. Sources of Technical Assistance
B. State Tree Lists
C. Tree Selection Data
D. Plants that Provide Resources for Wildlife
E. Wellsville City Tabloid
F. Interior Western United States Urban Forestry Survey
G. Tree Worker and Arborist Certification
H. How a Tree Grows
I. Funding a Community Forestry Program
J. Urban Forestry and Tree Care Workshops
K. Salt Lake City Urban Forestry Ordinance
L. Pruning Standards, International Society of Arboriculture, Western Chapter, 1988 Version
M. American Standard for Nursery Stock

APPENDICES

APPENDIX A

Sources of Technical Assistance

Sources of Technical Assistance

The following sources of technical assistance will be of help when beginning a community forestry program. They are broken into four categories: local, state, national and journals and other publications. Be sure to enlist the help of any or all of these sources.

Local Assistance

Local groups are mentioned by name here. They can usually be located in a phone directory, newspaper, nursery, parks department or library. It is unlikely that all of these groups will exist in your community; however, the ones that do may be able to help.

- Garden Clubs
- Environmental Clubs-
  - bird watching, hiking, etc.
- League of Women Voters
- Plant Societies
- Botanical/Horticultural
  - Associations
- Beautification Committees
- City Departments
  - Planning and Zoning
  - Building
  - Community Development
  - Parks & Recreation
  - Utility
  - etc.
- Private Utilities
- Chamber of Commerce
- Service Organizations
  - Rotary Club
  - Lions Club
  - Elks Club
  - etc.
- Architectural Review
  - Committees
- Neighborhood Councils
- Special Improvement
  - Districts
- Local Church Groups
- Senior Citizens Groups
- School Kids Groups
- Individual Enthusiasts
- Local, State and National
  - Forest or Park Offices
- Professional Contact People
  - ex. Arborists, Landscape
  - Architects, etc.
- Public/Private Arboreta
- Professional Organization
  - i.e., Irrigation Council,
  - Landscape Architects,
  - Nurserymen, etc.
- Philanthropic Organizations
- Prominent Business, Banks,
- Industrial Parks, Malls

State Assistance

Addresses for these groups also vary by state and region. The best information sources for locating these groups are the State Forester's Office and the State Agricultural Extension Forester. Contact with these two offices should be made early on in the program. Both of these offices have a wealth of resources available to community forestry programs. Many statewide groups will have local chapters and vice versa that can also help get a program started.

State Offices

Agricultural extension offices are often located in each county and at Universities and Colleges. Other sources of State Assistance are listed below.

Cooperative Extension Offices
Extension Forester
Legislature: elected representatives

State League of Cities and Towns

State Department of Lands

Division of State Lands and Forestry
League of Counties or County Governments

State Historical Society

University or College
Department of Landscape Architecture and Environmental Planning, Horticulture, Plant Sciences, Forestry

Government Offices

Cooperative Extension Office
Extension Forester
Utah State University
UMC 49
Logan, UT 84322
(801) 750-2200

Division of State Lands and Forestry
State Forester
355 West North Temple
3 Triad Center, Suite 400
Salt Lake City, UT 84180-1204
(801) 538-5508

Extension Forestry Office
Extension Forester
University of Idaho
College of FWR
Moscow, ID 83843
(208) 885-6356

Idaho Department of Lands
Urban Forestry Coordinator
P.O. Box 670
701 River Avenue
Coeur d'Alene, ID 83814
(208) 664-2171

Utah League of Cities and Towns
Executive Director
136 East South Temple
Suite 1240
Salt Lake City, UT 84111
(801) 328-1601

Utah State Historical Society
Director
300 Rio Grande
Salt Lake City, UT 84101
(801) 533-5755

Utah State University
Department Head
Department of Landscape Architecture & Environmental Planning
Utah State University
Logan, UT 84322-4005
(801) 750-3471

Federal Offices

USDA Forest Service
Forest Pest Management
Boise Field Representative
Boise Field Office
1750 Front Street
Room 202
Boise, ID 84302
(208) 364-4227

USDA Forest Service
State and Private Forestry
Urban Forestry Coordinator
Regional Office
Federal Building
324 25th Street
Ogden, UT 84401
(801) 625-5261

US Geological Survey
Salt Lake City, UT 84138
8105 Federal Building
125 South State Street
(801) 524-5652

Professional Organizations

International Society of Arboriculture
Western Chapter and Rocky Mountain Chapter
Murray City Forester
153 West 4800 South
Murray, UT 84107
(801) 264-2653

Ogden City
Department of Community Development
2540 Washington Blvd.
Floor 6
Ogden, UT 84401
(801) 629-8900

State Arboretum of Utah
Horticulturist
University of Utah
Building 436
Salt Lake City, UT 84112
(801) 581-5322

Urban Forester
Parks and Recreation
1965 West 500 South
Salt Lake City, UT 84104-3496
(801) 972-7814

National Assistance

The following list of national organizations was first compiled by the Olaf Unsoeld of the Southeastern United States Forest Service and updated for this edition by Michael Hanson, Project Designer. Many of these organizations will have both statewide and local affiliations which should be contacted.

National Assistance

American Association of Botanical Gardens and Arboreta, Inc.
Executive Director
P.O. Box 206
Swarthmore, PA 19081
(215) 328-9145

American Association of Nurserymen (AAN)
Director of Government Affairs
1250 I Street, NW
Suite 500
Washington, C.C. 20005
(202) 789-2900

American Forestry Association (AFA)
Executive Vice President
P.O. Box 2000
Washington D.C. 20013
or
1516 P Street, NW
Washington, D.C. 20005
(202) 667-3300

American Horticultural Society (AHS)
Horticulturist
P.O. Box 0105
Mt. Vernon, VA 22121
(703) 768-5700

American Phytopathological Society (APS)
Executive Vice President
3340 Pilot Knob Road
St. Paul, MN 55121
(612) 454-7250

American Planning Association (APA)
Executive Director
1313 East 60th Street
Chicago, IL 60637
(312) 955-9100

American Public Works Association (APWA)
Executive Director
1313 East 60th Street
Chicago, IL 60637
(312) 667-2200

American Registry of Professional Entomologists (ARPE)
9301 Annapolis Road
Suite 207
Lanham, MD 20706
(301) 731-4541

American Resort and Residential Association
Director
1220 L Street, NW
Suite 510
Washington, D.C. 20005
(202) 317-6700

American Society of Consulting Arborists (ASCA)
Executive Director
700 Canterbury
Clearwater, FL 34624
(813) 446-3356

American Society of Landscape Architects (ASLA)
Executive Vice President
4401 Connecticut Avenue, NW
5th Floor
Washington, D.C. 20008
(202) 686-2752

Associated Landscape Contractors of America
Executive Director
405 North Washington Street
Suite 104
Falls Church, VA 22046
(703) 241-4004

Council of Tree & Landscape Appraisers
1250 I Street, NW
Suite 504
Washington, D.C. 20005
(202) 789-2592

Elm Research Institute
Executive Director
Harrisville, NH 03450
(603) 827-3048

Entomological Society of America (ESA)
Executive Director
9301 Annapolis Road
Lanham, MD 20706-3115
(301) 731-4535

International Society of Arboriculture (ISA)
Executive Director
P.O. Box 908
303 West University
Urbana, IL 61801
(217) 328-2032

Lawn and Garden Distributors Association
Executive Director
1900 Arch Street
Philadelphia, PA 19103
(215) 564-3484

Mid West Urban Forestry Center
Director
P.O. Box 1781
Indianapolis, IN 46206-1781
(317) 736-9500

Mildred E. Mathias Botanical Gardens
University of California
Los Angeles, CA 90024-1606
(213) 825-3620

Municipal Arborist Urban Foresters' Society
Secretary
20 Court Street
Freehold, NF 07728

National Arbor Day Foundation
Arbor Lodge 100
Nebraska City, NE 68410
(402) 474-5655

National Arborist Association (NAA)
Secretary
174 Route 101
Bedford Station
Box 238
Bedford, NH 03102
(603) 472-2255

National Association of Homebuilders (NAHB)
Chief Executive Vice President
15th & M Street, NW
Washington, D.C. 20005
(202) 822-0200

National Association of State Foresters (NASF)
444 North Capitol Street, NW
Hall of States, Suite 526
Washington, D.C. 20001
(202) 624-5415

National Association of Towns and Township Officials
Executive Director
1522 K Street, NW
Suite 730
Washington, D.C. 20005
(202) 737-5200

National Institute of Municipal Law Officers
General Counsel
1000 Connecticut Ave.
Suite 902
Washington, D.C. 20036
(202) 466-5421

National League of Cities (NLC)
Executive Director
1301 Pennsylvania Avenue, NW
6th Floor
Washington, D.C. 20004
(202) 626-3010

National Recreation and Park Association
Executive Director
3101 Park Center Drive
Alexandria, VA 22302
(703) 820-4940

National Trust for Historic Preservation
President
1785 Massachusettes Avenue, NW
Washington, D.C. 20036
(202) 673-4000

Nursery Crops Research Laboratory, ARS
Secretary
359 Main Road
Delaware, Ohio 43015
(614) 363-1129

Sierra Club
Executive Director
730 Polk Street
San Francisco, CA 94109
(415) 776-2211

Small Towns Institute (STI)
Director
P.O. Box 517
Ellensburg, WA 98926
(509) 925-1830

Society of American Foresters (SAF)
Executive Vice President
5400 Grosvenor Lane
Bethesda, MD 20814
(202) 897-8720

Society of Municipal Arborists (SMA)
RR 3, Box 614
Williston, ND 58801

Soil and Water Conservation Society
Administrative Assistant
7515 NE Ankeny Road
Ankeny, IA 50021
(515) 289-2331

The Trust for Public Land (TPL)
President
116 New Montgomery, 4th Floor
San Francisco, CA 94105
(415) 495-4014

The Urban Land Institute
Executive Vice President
1090 Vermont Ave., NW
Suite 300
Washington, D.C. 20005
(202) 289-8500

Utility Arborist Association (UAA)
c/o Ohio Edison Company
76 South Main Street
Akron, OH 44308
(216) 384-5713

USDA Forest Service
Pacific Southwest Region
Urban Forestry Coordinator
630 Sansome SA
San Francisco, CA 94111
(415) 556-8876

USDA Forest Service
Pacific Northwest Region
Urban Forestry Coordinator
319 SW Pine St, P.O. Box 3623
Portland, OR 97208
(503) 326-2729

USDA Forest Service
Southern Region
Urban Forestry Specialist
1720 Peachtree Road N.W.
Atlanta, GA 30367
(404) 347-7203

USDA Forest Service
North Central Forest Experiment Station
Project Leader
"Managing Urban and High-Use Recreation Settings"
Building C, 5801 N. Pulaski Road
Chicago, IL 60646
(312) 886-3217

USDA Forest Service
Northeastern Forest Experiment Station
Project Leader
"Structure and Function of the Urban Forest"
State University of New York
5 Moon Library
Syracuse, NY 13210
(315) 470-6729

USDA Forest Service
Northeast Area State and
Private Forestry
Urban Forestry Specialist
370 Reed Road
Broomall, PA 19008
(215) 690-3138

USDA Forest Service
Northern Region
Urban Forestry Coordinator
Federal Bldg, P.O. Box 7669
Missoula, MT 59807
(406) 329-3521

USDA Forest Service
Rocky Mountain Region
Urban Forestry Coordinator
11177 W 8th Ave, Box 25127
Lakewood, CO 80225
(303) 236-9545

USDA Forest Service
Southwestern Region
Urban Forestry Coordinator
Federal Building, 517 Gold Ave., S.W.
Albuquerque, NM 87102
(505) 842-3292

USDA Forest Service
Pacific Southwest Forest and Range
Experimental Station
Project Leader
"Urban Forestry Research"
1960 Addison St.
Berkely, CA 94704
(415) 486-3191

USDA Forest Service
Northeastern Forest Experiment Station
Project Leader
"Physical Amenities and Water Supplied
by Urban and Community Forests."
301 Forest Resources Laboratory
University Park, PA 16802
(814) 863-1933

US Geological Survey
<u>Public Inquiries Offices</u>

Anchorage, Alaska
4230 University Dr. Rm 101
Anchorage, AL 99508-4664
(907) 561-5555
and
E-146 Federal Building
701 C Street
Anchorage, AL 99513
(907) 271-4307

Denver, Colorado 80294
169 Federal Building
1961 Stout Street
(303) 844-4169

Los Angeles, CA 90012
7638 Federal Building
300 North Los Angeles Street
(213) 894-2850

Menlo Park, CA 94025
Building 3, Room 3128
Mail Stop 533
345 Middlefield Road
(415) 329-4390

Reston, Virginia 22092
503 National Center
Room 1-C-402
12201 Sunrise Valley Dr.
(703) 648-6892

Salt Lake City, UT 84138
8105 Federal Building
125 South State Street
(801) 524-5652

San Francisco, CA 94111
504 Custom House
555 Battery Street
(415) 556-5627

Spokane, Washington 99201
678 U.S. Courthouse
West 920 Riverside Avenue
(509) 456-2524

Washington, DC 20240
Department of the Interior
18th and C Streets NW
(202) 343-8073

Maps may also be purchased at:

Rolla, Missouri 65401
Mid-Continent Mapping
Center-NCIC
1400 Independence Road
(314) 341-0851

NSTL Station, MS 39529
National Space Technology
Laboratories-NCIC
Building 3101
(601) 688-3544

APPENDIX B

State Tree Lists and
Sources of Tree Information

"Tree lists are ever changing and never complete. New trees continue to be developed at university research stations, commercial production nurseries, regional botanical gardens and arboreta. Visit development locations and arboretums to learn of new trees and to see trees displayed in mature size."

W. Richard Hildreth, Director
Red Butte Gardens and Arboretum
University of Utah

TREES FOR ARIZONA

Publications and Sources for Tree Information

Southwest Landscaping to Save Energy and Water by Greg McPherson and Charles Sacamano, Agricultural Communications, University of Arizona, Tucson, AZ 1989. (Includes tree list and selection information)

Desert Trees for Urban Landscapes, Published by Arizona Plant Society.

Trees and shrubs of the Southwestern Deserts, Lyman Benson and Robert A Darrow, Third Edition, The University of Arizona Press/Tuscon, 1981

Arizona Native Plant Society
P.O. Box 41206
Tucson, Arizona 85717

Boyce Thompson Arboretum
U.S. Highway 60
Superior, Arizona 85273

Desert Botanical Garden
1201 N. Galvin Parkway
Phoenix, Arizona 85008

Tucson Botanical Garden
2150 N. Alvernon Way
Tucson, Arizona 85716

Extension Horticulturalist
Plant Science Department
University of Arizona
Tucson, Arizona 85721

The Arboretum at Flagstaff
Transition Zone Horticultural Institute, Inc.
P.O. Box 670
Flagstaff, Arizona 86002

TREES FOR COLORADO

18 "TRIED AND TRUE TREES"

Large 40'

Bur Oak	*Quercus macrocarpa*
Hackberry	*Celtis occidentalis*
Autumn Purple	*Fraxinus americana 'Autumn Purple'*
Green Ash (Elev. > 6000')	*Fraxinus pennsylvanica*
Narrowleaf Cottonwood (Elev. > 6000')	*Populus angustifolia*
Lodgepole Pine (Elev. > 6000')	*Pinus contorta*

Medium 25'-40'

Norway Maple	*Acer platanoides*
Littleaf Linden	*Tilia cordata*
Kentucky Coffeetree	*Gymnocladus dioicus*
Quaking Aspen (Elev. > 6000')	*Populus tremuloides*
Shubert Chokecherry (Elev. > 6000')	*Prunus melanocarpa 'Shubert'*
Mayday Tree (Elev. > 6000')	*Prunus melanocarpa padus*

Small 25'

Tatarian Maple	*Acer tataricum*
Bigtooth Maple	*Acer grandidentatum*
Ohio Buckeye	*Aesculus glabra*
Amur Maple (Elev. > 6000')	*Acer ginnala*
River Birch (Elev. > 6000')	*Betula occidentalis*
Ussarian Pear (Elev. > 6000')	*Prunus ussuriensis*

5 TREES "WORTH TRYING"

Eastern Red Maple	*Acer rubrum*
European Hornbean	*Carpinus betulus*
Goldenrain Tree	*Koelreuteria paniculata*
Swamp White Oak	*Quercus bicolor*
Turkish Hazel	*Corylus colurna*

5 TREES "TO PLANT LESS OF"

Honey Locust	*Gleditsia sp.*
Silver Maple	*Acer saccharinum*
Cutleaf Weeping Birch	*Betula pendula 'Dalecarlica'*
Russian Olive	*Elaeagnus angustifolia*
Silver Elm	*Ulmus pumila*

TREES FOR IDAHO

15 "TRIED AND TRUE TREES"

Large 40'

Marshall Seedless Ash
Patmore Ash
Emerald Queen Maple
Shade Master Honey Locust
Paper Birch
Littleleaf Linden
Olympic Linden

Medium 25'-40'

Sunburst Honey Locust
Common Hackberry
Mountain Ash
Schubert Cherry
Canada Red Cherry
Mayday Tree

Small 25'

Bechtel Crabapple
Newport Flowering Plum
Quaking Aspen

3 TREES "WORTH TRYING"

Common Hackberry
Souixland Poplar
Camperdown Elm

3 TREES "TO PLANT LESS OF"

Weeping Willow
Siberian Elm
European White Birch

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Sunset Western Garden Book, Lane Publishing Co., Menlo Park, California

Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses, Third Ed., Michael A. Dirr, Department of Horticulture, University of Georgia, Stipes Publishing Company, Champaign, Illinois

Idaho State Arboretum, Boise, Idaho

Compiled by: Julie Jacobson and Ann Bates, Down to Earth, 1615 North Woodruff, Idaho Falls, Idaho 83401

Qualification: This list is limited and should be used in conjunction with the referenced sources.

TREES FOR IOWA

SHADE AND STREET TREES FOR IOWA

RECOMMENDED TREES

Large 40'+

Conifers**

White Fir	*Abies concolor*
Norway Spruce	*Picea abies*
White Spruce	*Picea glauca*
White Spruce	*Picea glauca var black hills*
Blue Spruce	*Picea pungens*
Jack Pine	*Pinus banksiana*
Red Pine	*Pinus resinosa*
Austrian Pine	*Pinus nigra*
Ponderosa Pine	*Pinus ponderosa*
Eastern-White Pine	*Pinus strobus*
Scotch Pine	*Pinus sylvestrus*
Douglas-Fir	*Pseudotsuga menziesii*
Eastern Hemlock	*Tsuga canadensis*
European Larch	*Larix decidua*
Japanese Larch	*Larix kaempferi*

Deciduous

Sugar Maple	*Acer saccharum*
White Ash	*Fraxinus americana*
Butternut	*Juglans cinerea*
Black Walnut	*Juglans nigra*
English Walnut	*Juglans regia*
Sweet Gum*	*Liquidambar styraciflua*
Yellow Poplar*	*Liriodendron tulipifera*
American Sycamore	*Platanus occidentalis*
White Oak	*Quercus alba*
Northern Red Oak	*Quercus rubra*
American Basswood	*Tilia americana*
Black Maple	*Acer nigrum*
Norway Maple	*Acer platanoides*
Pecan*	*Carya illinoensis*
Big Shellbark Hickory	*Carya laciniosa*
Shagbark Hickory	*Carya ovata*
Mockernut Hickory*	*Carya tomentosa*
Hackberry	*Celtis occidentalis*
Black Ash	*Fraxinus nigra*
Thornless Honeylocust	*Gleditsia triacanthos* var *inermis*
Kentucky Coffeetree	*Gymnocladis dioicus*
Cucumber Tree	*Magnolia acuminata*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
English Oak	*Quercus robur*
Black Oak	*Quercus velutina*

Medium 30'-40'

Conifers**

Rocky Mt Juniper	*Juniperus scopulorum*
Eastern Redcedar	*Juniperus virginiana*
Chinese Juniper	*Juniperus chinensis*
Arborvitae	*Thuja occidentalis*

Deciduous

Horsechestnut	*Aesculus hippocastanum*
River Birch	*Betula nigra*
Paper Birch	*Betula papyrifera*
Bitternut Hickory	*Carya cordiformis*
Quaking Aspen	*Populus tremuloides*
Black Cherry	*Prunus serotina*
Little Leaf Linden	*Tilia chondata*
Chinkapin Oak	*Quercus muelenbergia*
Redmond Linden	*Tilia x euchlora*
Ginko	*Ginko biloba*
Blue Ash	*Fraxinus quadrangulata*

Small < 30'

Conifers

Mugho Pine	*Pinus mugoensis*
Junipers	*Juniperus* sp.
Yews	*Taxus* sp.
Globe Arborvitae	*Thuja occidentalis 'Globe'*

Deciduous

Ohio Buckeye	*Aesculus glabra*
Paw Paw	*Asima triloba*
Downy Serviceberry	*Amelanchier leaevis*
European Hornbeam	*Carpinus caroliniana*
Yellowwood	*Cladrastis lutea*
Downy Hawthorn	*Crataegus molis*
Crabapples	*Malus* sp.
Flowering Crabs	*Malus* sp.
Hop Hornbeam	*Ostrya Virginiana*
Mayday Tree	*Prunus padus var commutata*
Bradford Pear*	*Pyrus calleryana 'Bradford'*
Am. Mt Ash	*Sorbus americana*
Japanese Pagoda Tree	*Sophora japonica*
Amur Maple	*Acer ginnala*
Mountain Maple	*Acer spicatum*
Shadbush	*Amelanchier canadensis*
Redbud	*Cercis canadensis*
Flowering Dogwood*	*Cornus florida*
Japanese Tree Lilac	*Syringa reticulata*
Hawthorn	*Crataegis* sp.
Sweet Birch	*Betula lenta*

NOT RECOMMENDED FOR
SHADE OR STREET TREES

Boxelder	*Acer negundo*
Siberian Elm	*Ulmus pumila*
Chinese Elm	*Ulmus parviflori*
Eastern Cottonwood	*Populus deltoides*
White Poplar	*Populus alba*
Lombardy Poplar	*Populus nigra 'Italica'*
Bolleana Poplar	*Populus alba 'Pyramidalis'*
Willows	*Salix* sp.
Tree of Heaven	*Alanthis altissima*
White Mulberry	*Morus alba*
Red Mulberry	*Morus rubra*
American Elm	*Ulmus americana*

HARDY-BUT PLANT LESS OF

Green Ash	*Fraximus pensylvanica*
Silver Maple	*Acer saccharinum*
Northern Catalpa	*Catalpa speciosa*
Pin Oak	*Quercus palustris*
Black Locust	*Robinia pseudoacacia*
European Mountain Ash	*Sorbus aucuparia*
Russian Olive	*Elaeagnus angustifolia*
Cutleaf Weeping Birch	*Betula pendula 'Dalecarlica'*

PUBLICATIONS AND SOURCES OF INFORMATION

Landscape Plants for Iowa, PM 212 Cooperative Extension Services. Iowa State University, Ames, 1984.

Compiled by: John Walkowiak, Service Forestry Bureau, Iowa Department of Natural Resources, Des Moines, Iowa 50319-0034.

Qualification: This list is limited and should be used in conjunction with the referenced sources.

* Can survive in SE Iowa only.
** Conifers not recommended for street trees.

TREES FOR KANSAS

15 "TRIED AND TRUE TREES"

		East	Cent.	West
Large 60'+				
Bur Oak	*Quercus macrocarpa*	X	X	X
Red Oak	*Quercus rubra*	X	X	X
American Sycamore	*Platanus occidentalis*	X	X	X
Hackberry	*Celtis occidentalis*	X	X	X
Medium 30'-60'				
Kentucky Coffeetree	*Gymnocladus dioicus*	X	X	X
Honeylocust	*Gleditsia triacanthos*	X	X	X
White Ash	*Fraxinus americana*	X	X	X
Sugar Maple	*Acer saccharum*	X	X	X
Norway Maple	*Acer platanoides*	X	X	X
Sweetgum	*Liquidambar styraciflua*	X	X	X
Goldenrain	*Koelreuteria paniculata*	X	X	X
Osage Orange	*Maclura pomifera*	X	X	X
Small 30'				
Eastern Redbud	*Cercis canadensis*	X	X	X
Hawthorn	*Crataegus spp.*	X	X	X
Flowering Crabapples	*Malus cvs.*	X	X	X

5 TREES "WORTH TRYING"

		East	Cent.	West
Trident Maple	*Acer buergerianum*	X	X	
Japanese Tree Lilac	*Syringa reticulata*	X	X	
Japanese Zelkova	*Zelkova serrata*	X	X	X
Red Maple	*Acer rubrum*	X	X	
English Oak	*Quercus robur*	X	X	

5 TREES "TO PLANT LESS OF"

Purple Leaf Plum	*Prunus cvs.*	Small
Colorado Blue Spruce	*Picea pungens glauca*	Large
Pin Oak	*Quercus palustris*	Medium
Cottonwood	*Populus deltoides*	Large
Silver Maple	*Acer saccharinum*	Large

Publications and Sources for Tree Information

Popular Publications, Kansas State University, Cooperative Extension Service, Manhattan, Kansas, 1988.

Forestry

XC	-481	Street Trees for Kansas Communities (.35)
XL	-582	How To Plant a Tree (.25)
XL	-584	What to Look for At The Nursery (.25)
XL	-591	Managing Tree Plantings (.25)
XL	-592	Sample City Tree Ordinances (.30)
XL	-594	Sample Arbor Day Proclamation (.25)
XL	-596	Mulching Trees and Shrubs (.25)
XL	-599	Nursery Stock (.25)
XL	-600	Shrubs for Difficult Sites (.25)
XL	-601	Treating Injured Trees (.30)
XL	-606	Fertilizing Flowering Shrubs and Evergreens (.25)
XL	-610	How to Keep Your Trees Healthy (.25)
XL	-707	Fertilizing Trees and Shrubs (.25)

Horticulture

XC	-550	All About Pruning (.55)
XMF	-299	Small Deciduous Trees (.30)
XMF	-300	Medium Deciduous Trees (.30)
XMF	-301	Tall Deciduous Trees (.30)
XMF	-402	Ornamental Trees and Shrubs (.45)
XMF	-434	Answers To...What Shall I Plant? (.45)
XMF	-461	Evergreen Trees and Shrubs (.40)
XMF	-632	Ornamental Tree and Shrub Evaluation (.30)
XMF	-875	Flowering Crabapples (.40)
XS	-4	Residential Landscape Design (1.25)
NCR	-78	The Flowering Crabapple (1.25)

Insects and Diseases

XC	-586	Insect and Mite Control on Shade Trees and Woody Ornamentals (.70)
XC	-674	Tree Diseases in Kansas (.60)
XL	-722	Diplodia Tip Blight, Dothistroma Needle Blight and Brown Spot of Pines (.40)
XL	-763	Anthracnose Diseases of Shade Tree (.40)
XMF	-728	Bagworms (.25)
XMF	-748	Elm Leaf Beetles (.30)
XAF	-6	Hackberry Nipplegall Maker (.25)

Compiled by: James J. Nighswonger, Urban & Community Forestry Program Leader, Cooperative Extension Service, Department of Forestry, Manhattan, Kansas 66502

Qualifications: This list is limited and should be useds in conjunction with the referenced sources.

TREES FOR MINNESOTA

TREES - LARGE - 50' & OVER

Sugar Maple	*Acer saccharum*
Green Mountain Sugar Maple	*Acer saccharum 'Green Mountain'*
Hackberry	*Celtis occidentalis*
White Ash	*Fraxinus americana*
Green Ash	*Fraxinus pennsylvanica*
Honeylocust and its cultivars	*Gleditsia triacanthos var inermis*
Kentucky Coffeetree	*Gymnocladus dioicus*
White Oak	*Quercus alba*
Bur Oak	*Quercus macrocarpa*
Basswood or Linden	*Tilia americana*

TREES - MEDIUM - 25-50'

Norway Maple	*Acer platanoides*
Cleveland Norway Maple	*Acer platanoides 'Cleveland'*
Emerald Queen Norway Maple	*Acer platanoides 'Emerald Queen'*
Summer Shade Norway Maple	*Acer platanoides 'Summer Shade'*
Red Maple	*Acer rubrum*
Northwood Red Maple	*Acer rubrum 'Northwood'*
Ohio Buckeye	*Aesculus glabra*
River Birch	*Betula nigra*
Ginkgo	*Ginkgo biloba*
Ironwood	*Ostrya virginiana*
Pin Oak	*Quercus palustris*
Little leaf Linden	*Tilia cordata*
Greenspire Linden	*Tilia cordata 'Greenspire'*
Redmond Linden	*Tilia x euchlora 'Redmond'*

TREES - SMALL - UNDER 25'

Serviceberry or Shadblow	*Amelanchier laevis*
Amur Maple	*Acer ginnala*
Tatarian Maple	*Acer tatarica*
Blue Beech	*Carpinus caroliniana*
Cockspur Hawthorn	*Crataegus crus-galli inermis*
Thornless Cockspur Hawthorn	*Crataegus crus-galli inermis*
Russian Olive	*Elaeagnus angustifolia*
Princess Kay Plum	*Prunus nigra 'Princess Kay'*
Canada Red Chokecherry	*Prunus virginiana 'Canada Red'*
Japanese Tree Lilac	*Syringa reticulata*

Compiled by: Michael E. Zins, Landscape Arboretum, Box 39, 3675 Arboretum Drive, Chanhassen, MN 55317.

TREES FOR MONTANA

18 "TRIED AND TRUE TREES"

Large 40'

Norway Maple*	*Acer platanoides*
Sugar Maple*	*Acer saccharum*
Common Hackberry	*Celtis occidentalis*
Delta Hackberry	*Celtis occidentalis 'Delta'*
Green Ash	*Fraxinus pennsylvanica*
American Linden*	*Tilia americana*
Bur Oak	*Quercus macrocarpa*

Medium 25'-40'

Ohio Buckeye*	*Aesculus glabra*
Common Horsechestnut*	*Aesculus hippocastanum*
River Birch	*Betula nigra*
Honey Locust	*Gleditsia triacanthos*
European Mountain Ash	*Sorbus aucuparia*
Littleleaf Linden*	*Tilia cordata*

Small 25'

Amur Maple	*Acer ginnala*
Hawthorn	*Crataegus spp.*
Russian Olive	*Elaeagnus angustifolia*
Rock Mountain Juniper	*Juniperus scopulorum*
Flowering Crabapples	*Malus spp./cvs.*

5 TREES "WORTH TRYING"

Boxelder 'Baron'	*Acer negundo* 'Baron'
Ginkgo*	*Ginkgo biloba*
Black Walnut*	*Juglans nigra*
Mongolian Oak*	*Quercus mongolica*
Red Stem Willow	*Salix alba* 'Chermesina'

5 TREES "TO PLANT LESS OF"

European White Birch	*Betula pendula*
Lombardy Poplar	*Populus nigra 'Italica'*
White Poplar	*Populus alba*
Siberian Elm	*Ulmus pumila*
Weeping Willow	*Salix babylonica*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Trees for Missoula, 1988; Missoula Council on Urban Forestry and Missoula County Extension Service.

Ornamental and Shade Trees for Utah, Ec 406 Cooperative Extension Service, Utah State University, Logan, 1984.

A Woody Ornamental Plant Inventory, Research Report 96, George Evans and J.L. Murphy, Montana Agricultural Experiment Station, Montana State University, Bozeman, 1976.

North Dakota Urban & Community Forestry Handbook, North Dakota Forest Service, Craig Foss, 1989.

For additional information on tree species, contact your local Deparment of State Lands Service Forester or local County Extension Agent

Compiled by: Mark Lennon, Department of State Lands, Division of Forestry and Glenn Roloff, US Forest Service, Region 1, Missoula.

***Qualifications:** Indicates plants of questionable hardiness for Highline area (North Central and Northeast Montana) due to extreme fluctuations of winter temperatures. Consult local tree professionals before planting the indicated trees in the Highline area.

TREES FOR NEBRASKA

15 "TRIED AND TRUE TREES"

Large 35' and larger

Norway Spruce	*Picea abies*
River Birch	*Betula nigra*
Common Hackberry	*Celtis occidentalis*
Thornless Honeylocust	*Gleditsia triacanthos inermis*
American Sycamore	*Platanus occidentalis*
Douglas Fir	*Pseudotsuga menziesii*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Red Oak	*Quercus rubra*
American Linden	*Tilia americana*

Small 25'-35' and under

Amur Maple	*Acer ginnala*
Hawthorn	*Crataegus spps.*
Star Magnolia	*Magnolia stellata*
Crabapples	*Malus spp./cvs.*
Aristocrat Callery Pear	*Pyrus caleryana 'Aristocrat'*

5 TREES "WORTH TRYING"

Northwood Red Maple	*Acer rubrum 'Northwood'*
Kentucky Coffeetree	*Gymnocladus dioicus*
Common Larch	*Larix decidua*
Hornbeam	*Ostrya virginiana*
Eastern White Pine	*Pinus strobus*

5 TREES "TO PLANT LESS OF"

Crimson King Norway Maple	*Acer platanoides 'Crimson King'*
Silver Maple	*Acer saccharinum*
Green Ash	*Fraxinus pennsylvanica*
Austrian Pine	*Pinus nigra*
Bradford Pear	*Pyrus calleryana 'Bradford'*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Contact the Department of Forestry, Fisheries and Wildlife
Extension Forester
Plant Industries Building
UNL, East Campus
Lincoln, NE 68583
or your County Extension Office

Compiled by: David Mooter, Nebraska Forest Service, Community Forestry Program.

TREES FOR LAUGHLIN & LAS VEGAS, NEVADA AREAS

TREES TO PLANT MORE OF:

Mulga Tree	*Acacia anuera*
Mulga Tree	*Acacia coriacea*
Blackwood Acacia	*Acacia melanoxylon*
Blackwood Acacia	*Acacia salicina*
Guadalupe Palm	*Brahea edulis*
Carob	*Ceratonia siliqua*
Eastern Redbud	*Cercis canadensis*
Camphor Tree	*Cinnamomun camphora*
Hawthorn	*Crataegus spp.*
Bronze Loquat	*Eriobotrya deflexa*
American Sweetgum	*Liquidambar styraciflua*
Swan Hill Olive	*Olea europaea 'Swan Hill'*
Chir Pine	*Pinus roxburghii*
Texas Ebony	*Pithecellobium flexicaule*
Willow Pittosporum	*Pittosporum phillyraeoides*
Argentine Mesquite	*Prosopis alba*
Coast Live Oak	*Quercus agrifolia*
Heritage Live Oak	*Quercus virginiana* 'Heritage'
African Sumac	*Rhus lancea*
Globe Navajo Willow	*Salix matsudana* 'Navajo'
California Pepper Tree	*Schinus molle*

TREES TO PLANT LESS OF:

Italian Cypress	*Cupressus sempervirens*
Glossy Privet	*Ligustrum lucidum*
China Berry	*Melia azedarach*
White Mulberry	*Morus alba*
Common Olive	*Olea europaea*
Aleppo Pine	*Pinus halepensis*
Cottonwood	*Populus spp.*
Willow	*Salix spp.*
Siberian Elm	*Ulmus pumila*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Sunset New Western Garden Book, Lane Publishing Co., Menlo Park, California

Trees and Shrubs for Western Gardens, Gordon Courtright, Timber Press, Forest Grove, Oregon

Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses, Third Ed., Michael A. Dirr, Department of Horticulture, University of Georgia, Stipes Publishing Company, Champaign, Illinois

Trees and Shrubs for Dry California Landscapes, Plants for water conservation, Bob Perry, Department of Landscape Architecture, California State Polytechnic University, Pomona, California, Land Design Publishing, San Dimas, California

Plants for Dry Climates, How to Select, Grow & Enjoy, Mary Rose Duffield and Warren D. Jones, H.P. Books, Tucson, Arizona

Ornamental Plants, Their Care, Use, Propogation, and Identification, D. Dwight Wait, Modesto, California

Compiled by:

Robert Ll. Morris, Area Extension Specialist-Horticulture, Nevada Cooperative Extension, University of Nevada, Las Vegas, Nevada

Dr. Wes Miles, Curator, UNLV Herbarium, 4505 S. Maryland Parkway, Las Vegas, Nevada 89109

Jack Zunino, ASLA, JMA Architecture and Engineering, 4292 S. Maryland Parkway, Las Vegas, Nevada 89119

Karen Dyka, 3473 Villa Knoll, Las Vegas, Nevada 89120

Linn Mills, Nevada Cooperative Extension, 953 E. Sahara, ST&P Bldg. 207, Las Vegas, Nevada 89104

Dennis Swartzell, Director, UNLV Arboretum, 4505 S. Maryland Parkway, Las Vegas, Nevada 89109

Qualification: This list is limited and should be used in conjunction with the referenced sources.

TREES FOR NORTHERN NEVADA

Large 40'

FORMAL SHAPE

White Fir	*Abies concolor*
Incense Cedar	*Calocedrus decurrens*
Deodar Cedar	*Cedrus deodara*
White Ash	*Fraxinus americana*
Blue Ash	*Fraxinus quadrangulata*
Colorado Spruce	*Picea pungens*
Colorado Blue Spruce	*Picea pungens glauca*
Austrian Black Pine	*Pinus nigra*
Ponderosa Pine	*Pinus ponderosa*
London Planetree	*Platanus x acerifolia*
Columnar English Oak	*Quercus robur 'Columnaris'*
Korean Mountain Ash	*Sorbus alnifolia*

SEMI-FORMAL SHAPE

European Ash	*Fraxinus excelsior*
Raywood Ash	*Fraxinus oxycarpa 'Raywood'*
Green Ash	*Fraxinus pennsylvanica*
Common Hackberry	*Celtis occidentalis*
Honeylocust	*Gleditsia triacanthos*
Scotch Pine	*Pinus sylvestris*
Thornless Honeylocust	*Gleditsia triacanthos var. inermis*
White Oak	*Quercus alba*
Scarlet Oak	*Quercus coccinea*
Bur Oak	*Quercus macrocarpa*
Chinkapin Oak	*Quercus muhlenbergi*
Pin Oak	*Quercus palustris*
Willow Oak	*Quercus phellos*
Red Oak	*Quercus rubra*
Black Locust	*Robinia pseudoacacia*

INFORMAL SHAPE

Tree of Heaven	*Ailanthus altissima*
Redfruited Tree of Heaven	*Ailanthus altissima 'Erythrocarpa'*
Northern Catalpa	*Catalpa speciosa*

Medium 25' - 40'

FORMAL SHAPE

Hedge Maple	*Acer campestre*
Norway Maple	*Acer platanoides*
Red Horse Chestnut	*Aesculus x carnea*
Horse Chestnut	*Aesculus hippocastanum*
Carriere Hawthorn	*Crataegus x lavellei*
Idaho Locust	*Robinia ambigua 'Idahoensis'*
European Mountain Ash	*Sorbus aucuparia*

SEMI-FORMAL SHAPE

Black Hawthorn	*Crataegus douglasii*
Washington Hawthorn	*Crataegus phaenopyrum*
Arizona Cypress	*Cupressus glabra (C. arizonica)*
Osage Orange	*Maclura pomifera*

White Mulberry	*Morus alba*
Kingman White Mulberry	*Morus alba 'Kingman'*
Bristlecone Pine	*Pinus aristata*
Limber Pine	*Pinus flexilis*
Blue Oak	*Quercus douglasii*
Japanese Scholar Tree	*Sophora japonica*

Small 25'

FORMAL SHAPE

Globe Norway Maple	*Acer platanoides 'Globosum'*
Umbrella Catalpa	*Catalpa bignonioides 'Nana'*
Pinyon Pine	*Pinus edulis*
Eastern Arborvitae	*Thuja occidentalis*

SEMI-FORMAL SHAPE

Amur Maple	*Acer ginnala*
Siberian Peashrub	*Caragana arborescens*
Chinese Junipers	*Juniperus chinensis*
Common Juniper	*Juniperus communis*
Redberry Juniper	*Juniperus monosperma*
Utah Juniper	*Juniperus osteosperma*
Rocky Mountain Juniper	*Juniperus scopulorum*
Eastern Red Cedar	*Juniperus virginiana*
Goldenrain Tree	*Koelreuteria paniculata*
Crabapple	*Malus spp.*
Japanese Black Pine	*Pinus thunbergiana*
Singleleaf Pinon Pine	*Pinus monophylla*
Blireiana Plum	*Prunus x blireiana*
Cherry Plum	*P. cerasifera*
European Bird Cherry	*Prunus padus*
Western Chokecherry	*Prunus virginiana demissa*

INFORMAL SHAPE

Russian Olive	*Elaeagnus angustifolia*
Red King Russian Olive	*Elaegnus angustifolia 'Red King'*
Western Juniper	*Juniperus occidentalis*
Rocky Mountain White Oak	*Quercus gambelii*
Smooth Sumac	*Rhus glabra*
Staghorn Sumac	*Rhus typhina*
Silverleaf Buffaloberry (shrubby)	*Shepherdia argentea*
Tamarix, Salt Cedar	*Tamarix parviflora*

1. All trees require irrigation for the two or three years it takes them to establish. Most will be healthier with continued irrigation thereafter. Plants not considered at least moderately drought tolerant require continued watering.

2 Trees are subdivided into three groups. Formal trees are symmetrically shaped. Informal trees have an irregular form or outline. Semi-formal trees vary between formal and informal depending on age, environmental or cultural conditions.

3 Numerous cultivars of these species are available in the nursery or through mail order catalogs. Elms, poplars and willows are not recommended due to their disease, insect and cultural problems.

4 These trees grow well in Reno and most will perform throughout the communities of northern Nevada, except for mountainous, very cold sites.

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Hardy, Drought Tolerant and Moderately Salt Tolerant Trees for Northern Nevada, Wayne S Johnson, State Horticulture Specialist, Plant Science Department, John Balliette, Agent in Charge, Lander County, College of Agriculture, University of Nevada-Reno, Nevada Cooperative Extension.

Compiled from referenced publication:

Qualification: This list is limited and should be used in conjunction with the referenced sources.

TREES FOR NEW MEXICO

15 "TRIED AND TRUE TREES"

Large

Green Ash	*Fraxinus pennsylvanica*
Thornless Honeylocust	*Gleditsia triacanthos var inermis*
Western Catalpa	*Catalpa speciosa*
Colorado Spruce	*Picea pungens*
Douglas Fir	*Pseudoseuga menziesii*

Medium

European Mountain Ash	*Sorbus acuparia*
Washington Hawthorn	*Crataegus phaenopyrum*
Weeping Willow	*Salix babylonica*
Chinese Pistache	*Pistacia chinensis*
White Mulberry (male or fruitless)	*Morus alba*

Small

Pinyon Pine	*Pinus edulis*
Goldenrain Tree	*Koelreuteria paniculata*
Forestiera	*Forestiera neomexicana*
Russian Olive	*Elaeagnus angustifolia*
Crabapple	*Malus spp.*

5 TREES "WORTH TRYING"

Littleleaf Linden	*Tillia chordata*
Bur Oak	*Quercus macrocarpa*
Ginkgo	*Ginkgo biloba*
Tulip Tree	*Liriodendron tulipifera*
Bradford Pear	*Pyrus calleryana*

5 TREES "TO PLANT LESS OF"

London Planetree	*Plantinus acerifolia*
Siberian Elm	*Ulmus pumila*
Afghan Pine	*Pinus elderica*
European White Birch	*Betula pendula*
Tree of Heaven	*Ailanthus altissima*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following source for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Compiled by: Lynn Ellen Doxon, Extension Urban Horticulturist, Cooperative Extension Service, New Mexico State University, Ag and Resource Development Program Unit, Albuquerque, New Mexico, 87112.

TREES FOR NORTH DAKOTA

15 "TRIED AND TRUE TREES"

Large 40'

Common Hackberry	*Celtis occidentalis*
Fallgold Black Ash	*Fraxinus nigra 'Fallgold'*
Green Ash Cultivars	*Fraxinus pennsylvanica cultivars*
Bur Oak	*Quercus macrocarpa*
American Linden	*Tilia americana*
Redmond Linden	*Tilia x euchlora 'Redmond'*

Medium 25'-40'

Mancana Manchurian Ash	*Fraxinus mandshurica 'Mancana'*
Siberian Crabapple	*Malus baccata*
Laurel Willow	*Salix pentandra*
European Mountain Ash	*Sorbus aucuparia*
Littleaf Linden Cultivars	*Tilia cordata cultivars*

Small 25'

Amur Maple	*Acer ginnala*
Crabapple Cultivars	*Malus cultivars*
Amur Chokecherry	*Prunus maackii*
Showy Mountain Ash	*Sorbus decora*

7 TREES "WORTH TRYING"

Baron Maple	*Acer negundo 'Baron'*
Emerald Luster Norway Maple	*Acer platanoides 'Pond'*
Autumn Blaze White Ash	*Fraxinus americana 'Autumn Blaze'*
Ohio Buckeye	*Aesculus glabra*
Jacan Japanese Elm	*Ulmus japonica 'Jacan'*
Snowbird and Toba Hawthorn	*Crataegus x mordenensis 'Snowbird & Toba'*
Ussurian Pear	*Pyrus ussuriensis*

4 TREES "TO PLANT LESS OF"

Green Ash Cultivars	*Fraxinus pennsylvanica cultivars*
Dolgo Crabapple	*Malus 'Dolgo'*
Poplar Cultivars	*Populus cultivars*
Shubert Chokecherry	*Prunus virginiana 'Shubert'*

Publications and Sources for Tree Information

North Dakota Urban and Community Forestry Handbook, Craig C. Foss, North Dakota Forest Service, Research Extension Center, Carrington, ND 58421.

North Dakota State University Arboretum, Absaraka, ND (Approximately 100 different genera of trees and shrubs are identified for planting in North Dakota. Contact Dr. Dale Herman, Dept. of Horticulture, North Dakota State University, Fargo, ND 58105.

Trees and Shrubs for North Dakota/Design Evaluation, Donald G. Hoag, Extension Bulletin No. 13, Cooperative Extension Service, North Dakota State University, 1970.

Compiled by: Craig C. Foss, Community Forestry Specialist, North Dakota Forest Service.

Reviewed by: Paul Blumhardt, City Forester, Bismarck, North Dakota;
Dr. Dale Herman, Professor, ND State University, Fargo, North Dakota;
John Staley; City Forester, Grand Forks, North Dakota;
John Wesolowski, City Forester, Fargo, North Dakota.

Qualification: This list is limited and should be used in conjunction with the referenced sources. The ND Urban and Community Forestry Handbook contains the most recent listing of recommended trees for North Dakota. "Trees and Shrubs for North Dakota" is an excellent reference for developing an understanding of various tree and shrub species, but must be supplemented with up-to-date recommendations for species cultivars. This information is available through the North Dakota Forest Service, North Dakota State University, local city foresters, or your local nursery/garden center.

TREES FOR URBAN PLANTING, OKLAHOMA

15 "TRIED AND TRUE TREES"

Large 40'

Baldcypress	*Taxodium distichum*
Bur Oak	*Quercus macrocarpa*
Green Ash	*Fraxinus pennsylvanica*
Pecan	*Carya illinoensis*
Sycamore	*Platanus occidentalis*

Medium 25'-40'

Lacebark Elm	*Ulmus parvifolia*
Golden Raintree	*Koelreuteria paniculata*
Fruitless Mulberry	*Morus rubra*
Chinese Pistache	*Pistacia echinensis*
Bradford Pear	*Pyrus calleryana 'Bradford'*

Small 25'

Autum Olive	*Elaeagnus umbellata*
Crabapple Cultivars	*Malus cultivars*
Redbud	*Cercis canadensis*
Smoketree	*Cotinus coggygria*
Yaupon Holly	*Ilex vomitoria*

5 TREES "WORTH TRYING"

Hackberry	*Celtis occidentalis*
Fruitless Osage-Orange	*Maclura pomifera*
Male Kentucky Coffeetree	*Gymnocladus dioicus*
Western Soapberry	*Sapindus drummondii*
Swamp White Oak	*Quercus lyrata*

5 TREES "TO PLANT LESS OF"

Lombardy Poplar	*Populus nigra 'Italica'*
Pin Oak	*Quercus palustris*
Purple Leaf Plum	*Prunus cerasifera*
Silver Maple	*Acer saccharinum*
Sweet Gum	*Liquidambar styraciflua*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Forest Trees of Oklahoma, Oklahoma Forestry Division, State Department of Agriculture.

Know It and Grow It, Carl E. Whitcomb, 1978.

Oklahoma State University Fact Sheets, Nos. 6480, 6409, 6412, 6416.

Compiled by: Timothy Cannon, Forestry Division, Department of Agriculture, State of Oklahoma.

TREES FOR EASTERN OREGON

Deciduous

Boxelder	*Acer negundo*	Sh
Golden Boxelder	*Acer negundo 'Goldspot'*	Sh
Silverleaf Boxelder	*Acer negundo 'Silverleaf'*	Sh
Norway Maple	*Acer platanoides*	S, Sh
Schwedlers Maple	*Acer platanoides 'Schwedleri'*	S, Sh
Sycamore Maple	*Acer pseudoplatanus*	S, Sh
Silver Maple	*Acer saccharinum*	Sh
Sugar Maple	*Acer saccharum*	S, Sh, C
Horse Chestnut	*Aesculus hippocastanum*	Sh, F
Tree of Heaven	*Ailanthus altissima*	Sh, F
European White Birch	*Betula pendula*	L
Cutleaf European White Birch	*Betula pendula 'Cutleaf'*	L
Southern Catalpa	*Catalpa bignonioides*	Sh
Hackberry	*Celtis occidentalis*	Sh
Flowering Dogwood	*Cornus florida*	L, F
Redflowering Dogwood	*Cornus florida 'Redflowering'*	L,F
English Hawthorn	*Crataegus oxyacantha*	L, F, Fr
Pauls Scarlet Hawthorn	*Crataegus oxyacanth 'Pauls' Scarlet*	L, F
White Ash	*Fraxinus americana*	Sh
Green Ash	*Fraxinus pennsylvanica lanceolata*	Sh
Common Honeylocust	*Gleditsia triacanthos*	Sh
Thornless Honeylocust	*Gleditsia triacanthos inermis*	Sh
Black Walnut	*Juglans nigra*	Sh, C
Tulip Tree	*Liriodendron tulipifera*	S, Sh
Japanese Flowering Crabapple	*Malus floribunda*	L, F
Bechtel Crabapple	*Malus ioensis 'Bechtel'*	L, F
Black Poplar	*Populus nigra 'Lombardy'*	Sh
Blireiana Plum	*Prunus blireiana*	L, F
Pissard Myrobalan Plum	*Prunus cerasifera 'Pissard'*	L, F
Kwansan Oriental Cherry	*Prunus serrulata 'Kwansan'*	L, F
Shirotae Oriental Cherry	*Prunus subhirtilla 'Shirotae'*	L, F
Beni-Higan Oriental Cherry	*Prunus subhirtilla 'Beni-Higan'*	L, F
Scarlet Oak	*Quercus coccinea*	S, Sh, C
Red Oak	*Quercus borealis*	S, Sh, C
Pin Oak	*Quercus palustris*	S, Sh, C
Black Locust	*Robinia pseudoacacia*	Sh, F
Babylon Wooping Willow	*Salix babylonica*	Sh
European Mountain Ash	*Sorbus aucuparia*	L, Fr
American Linden	*Tilia americana*	S, Sh
Littleleaf Linden	*Tilia cordata*	S, Sh
American Elm	*Ulmus americana*	S, Sh
Chinese Elm	*Ulmus parvifolia*	S, Sh
Siberian Elm	*Ulmus pumila*	Sh

Conifers

Cascade Fir	*Abies amabilis*	P
Balsam Fir	*Abies balsamea*	P
White Fir	*Abies concolor*	L
Colorado Juniper	*Juniperus scopulorum*	L
Redcedar	*Juniperus virginiana*	L
Schott Redcedar	*Juniperus virginiana 'Schott'*	L
Silver Redcedar	*Juniperus virginiana 'Silver'*	L
Western Larch	*Larix occidentalis*	P, C
Norway Spruce	*Picea abies*	P
Colorado Spruce	*Picea pungens*	P

Blue Colorado Spruce	*Picea pungens glauca*	L
Red Spruce	*Picea rubra*	P
Jack Pine	*Pinus banksiana*	P
Shore Pine	*Pinus contorta*	P
Western White Pine	*Pinus monticola*	P
Austrian Pine	*Pinus nigra*	P
Ponderosa Pine	*Pinus ponderosa*	P
Red Pine	*Pinus resinosa*	P
White Pine	*Pinus strobus*	P
Scotch Pine	*Pinus sylvestris*	P
Canada Hemlock	*Tsuga canadensis*	L

KEYS TO SYMBOLS

S - STREET TREES

This list excludes street trees which are not recommended by the League of Oregon Cities.

Sh - SHADE TREES

Shade Trees included in this list are , for the most part, most useful around homes and parks.

L - ORNAMENTAL LAWN TREES

The ornamental lawn trees are those which for their texture, color of foliage, or for their flowering or fruit habits make good ornamental trees. Many could be used as small shade trees, but their chief value lies in their ornamental quality.

F - FLOWERING TREES

The flowering trees noted in this list are designated as such because of the landscape value of their flowering habits.

FR - ORNAMENTAL FRUIT

Ornamental fruit trees are designated only when the fruit distinguishes itself sufficiently to make it an attractive decoration.

C - GOOD FALL COLOR

Most of the trees in this list have some sort of fall color, but only those have been noted which distinguish themselves by having a truly noteworthy color.

R - ROADSIDE TREES

In this instance are distinguished from street trees because it is felt that roadside tree plantings done in the same manner as street tree plantings are not necessarily good. It is felt that roadside trees should be restricted primarily to the trees native to any particular spot along the highway, and that in any case, the trees should not be planted in rows to form a tunnel through which the road passes. Such a roadside treatment probably was good in the horse and buggy days when people spent greater periods of time in travel from one point to another.

W - WINDBREAKS

Those trees designated for windbreaks have been found useful in their particular areas.

P - CONIFERS FOR PARKS OR LARGE ESTATES

These trees are best used in parks or large estates because of the rapid growth or ultimate size of the trees. Those conifers designated with the L are those which lend themselves to the landscape as ornamental trees in their youth.

Qualification: Dated material which is the best available (at time of printing)

TREES FOR SOUTH DAKOTA

TRIED AND TRUE TREES

Deciduous, Tall (40'+)

Green Ash	*Fraxinus pennsylvanica*
Marshall's Seedless Ash	*Fraxinus pennsylvanica 'Marshall's Seedless'*
Northern Catalpa	*Catalpa speciosa*
Hackberry	*Celtis occidentalis*
Honeylocust & cultivars	*Gleditsia triacanthos*
American Linden*	*Tilia americana*
Littleleaf Linden & Cultivars*	*Tilia cordata*
Norway Maple & Cultivars*	*Acer platanoides*
Sugar Maple*	*Acer saccharum*
Bur Oak	*Quercus macrocarpa*
White Poplar	*Populus alba*
Black Walnut*	*Juglans nigra*

Evergreen, Tall (40'+)

Austrian Pine	*Pinus nigra*
Ponderosa Pine	*Pinus ponderosa*
Scotch Pine	*Pinus sylvestris*
Colorado Blue Spruce	*Picea pungens*
Norway Spruce	*Picea abies*
White Spruce (Black Hills)	*Picea glauca var. densata*

Deciduous, Medium (25'-40')

European Mountain Ash	*Sorbus aucuparia*
Paper Birch	*Betula papyrifera*
Ohio Buckeye	*Aesculus glabra*
Black Cherry	*Prunus serotina*
Common Chokecherry & Cultivars	*Prunus virginiana*
Canadian Red Cherry	*Prunus virginiana 'Shubert'*
American Hop-hornbeam	*Ostrya virginiana*
Red Mulberry	*Morus rubra*
White Mulberry	*Morus alba*
Golden Weeping Willow	*Salix alba 'Tristis'*
White Willow & Cultivars	*Salix alba*

Evergreen, Medium (25'-40')

Eastern Red Cedar	*Juniperus virginiana*
Rocky Mountain Juniper	*Juniperus scopulorum*
Northern White Cedar*	*Thuja occidentalis*

Deciduous, Small (25')

Common Buckthorn	*Rhamnus cathartica*
Crabapples	*Malus sp.*
Hawthorns	*Crataegus sp.*
Amur Maple	*Acer ginnala*
Russian Olive	*Elaeagnus angustifolia*

TREES "WORTH TRYING"

Deciduous

Bigtooth Aspen	*Populus grandidentata*

Quaking Aspen	*Populus tremulodies*
Kentucky Coffeetree*	*Gymnocladus dioicus*
Amur Corktree*	*Phellodendron amurense*
Ginkgo*	*Ginkgo biloba*
European Larch*	*Larix decidua*
Siberian Larch*	*Larix sibirica*
Black Locust*	*Robinia pseudoacacia*
Northern Red Oak*	*Quercus rubra*
Sycamore*	*Platanus occidentalis*

Evergreen

Douglas-Fir	*Pseudotsuga menziesii*
Eastern White Pine*	*Pinus strobus*
Jack Pine	*Pinus banksiana*

5 TREES "TO PLANT LESS OF"

Boxelder	*Acer negundo*
Cottonwood	*Populus deltoides*
Siberian Elm	*Ulmus pumila*
Silver Maple	*Acer saccharinum*
Lombardy Poplar	*Populus nigra 'Italica'*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources of Tree Information in South Dakota

Trees of South Dakota, Circular 566, by Paul E. Collins and L. L. Helwig, Cooperative Extension Service, South Dakota State University, Brookings, South Dakota.

Native Shrubs of South Dakota, Extension Circular 706, by Larry Helwig, Cooperative Extension Service, South Dakota State University, Brookings, South Dakota.

Deciduous Trees for South Dakota Landscapes, Bulletin 578, by Dale E. Herman, Agricultural Experiment Station, South Dakota State University, Brookings, South Dakota, May 1971.

Tree Selection Guide, Fact Sheet 661, by Larry Helwig, Cooperative Extension Service, South Dakota State University, Brookings, South Dakota.

Trees and Shrubs for the Northern Plains, by Donald G. Hoag, North Dakota State University, North Dakota Institute for Regional Studies, Fargo, North Dakota, 1965.

Compiled by David W. Erickson, State of South Dakota, Division of Forestry, Anderson Building, 445 E. Capitol Ave., Pierre, South Dakota 57501

***Qualification;** An asterik placed after the common name of a tree species indicates that the respective tree is suggested only for favorable sites in more eastern portions of the state.

TREES FOR EASTERN TEXAS

15 "TRIED AND TRUE TREES"

Large 40'

Southern Red Oak	*Quercus falcata*
Southern Magnolia	*Magnolia grandiflora*
Southern Sugar Maple	*Acer barbatum*
Laurel Oak	*Quercus laurifolia*
American Holly	*Ilex opaca*

Medium 25'-40'

Live Oak	*Quercus virginiana*
Blue Jack Oak	*Q. incana*
Cherry Laurel	*Prunus caroliniana*
Sassafras	*Sassafras albidum*
Red Maple	*Acer rubrum*

Small 25'

Flowering Dogwood	*Cornus Florida*
Fringe Tree	*Chionanthus virginica*
Eastern Redbud	*Cercis canadensis var. canadensis*
Yaupon Holly	*Ilex vomitoria*
Chalk Maple	*Acer leucoderme*

5 TREES "WORTH TRYING"

Farkleberry	*Vaccinium arboreum*
Wax Myrtle	*Myrica cerifera*
Pyramid Magnolia	*Magnolia pyramidata*
Flatwood Plum	*Prunus umbellata*
Hop Hornbeam	*Ostrya virginiana*

5 TREES "TO PLANT LESS OF"

Fruitless Mulberry	*Morus alba 'Fruitless'*
Mimosa or Silk Tree	*Albizia julibrissin*
Silver Maple	*Acer saccharinum*
Siberian Elm	*Ulmus pumila*
Modesto Ash	*Fraxinus velutina 'Modesto'*

TREES FOR THE RIO GRANDE PLAINS TEXAS

15 "TRIED AND TRUE TREES"

Large 40'

Huisache	*Acacia farnesiana*
Escarpment Live Oak	*Quercus fusiformis*
Anacua	*Ehretia anacua*
Texas Ash	*Fraxinus texensis*
Cedar Elm	*Ulmus crassifolia*

Medium 25'-40'

Mesquite	*Prosopis glandulosa var. glandulosa*
Wright Acacia	*Acacia wrightii*
Texas Palmetto	*Sabal mexicana*
Texas Pistache	*Pistacia texana*
Texas Red Oak	*Quercus texana*

Small 25'

Texas Redbud	*Cercis canadensis var. texensis*
Blackbrush	*Acacia rigidula*
Texas Persimmon	*Diospyros texana*
Wild Olive	*Cordia boissieri*
Twisted Acacia	*Acacia tortuoso*

5 TREES "WORTH TRYING"

Texas Ebony	*Pithecellobium flexicaule*
Lacey Oak	*Quercus laceyi*
Western Soapberry	*Sapindus drummondii*
Chisos Red Oak	*Quercus gravesii*
Southern Wax Myrtle	*Myrica cerifera*

5 TREES "TO PLANT LESS OF"

Mexican Ash	*Fraxinus berlandieriana*
Modesto Ash	*Fraxinus velutina 'Modesto'*
Siberian Elm	*Ulmus pumila*
Mimosa or Silk Tree	*Albizia julibrissin*
Fruitless Mulberry	*Morus alba 'Fruitless'*

TREES FOR CENTRAL, NORTH-CENTRAL, TRANS-PECOS AND WEST TEXAS

15 "TRIED AND TRUE TREES"

Large 40'

Shumard Red Oak	*Quercus shumardii*
Bur Oak	*Quercus macrocarpa*
Escarpment Live Oak	*Quercus fusiformis*
Cedar Elm	*Ulmus crassifolia*
Texas Ash	*Fraxinus texensis*

Medium 25'-40'

Mesquite	*Prosopis glandulosa var. glandulosa*
Texas Red Oak	*Quercus texana*
Desert Willow	*Chilopsis linearis*
Western Soapberry	*Sapindus drummondii*
Vasey Oak	*Quercus pungens var. vaseyana*

Small 25'

Mountain Mahogany	*Cercocarpus montanus*
Mexican Redbud	*Cercis canadensis var. mexicana*
Bigelow Oak	*Quercus sinuata var. breviloba*
Mohr Oak	*Quercus mohriana*
Weeping Juniper	*Juniperus flaccida*

5 TREES "WORTH TRYING"

Prairie Flameleaf Sumac	*Rhus lanceolata*
Wright Acacia	*Acacia wrightii*
Chinkapin Oak	*Quercus muehlenbergii*
Texas Redbud	*Cercis canadensis var. texensis*
Mexican Plum	*Prunus mexican*

5 TREES "TO PLANT LESS OF"

Fruitless Mulberry	*Morus alba 'Fruitless'*
Siberian Elm	*Ulmus pumila*
Box Elder	*Acer negundo*
Arizona (Modesto) Ash	*Fraxinus velutina*
Black Locust	*Robinia pseudoacacia*

TREES FOR HIGH PLAINS TEXAS

15 "TRIED AND TRUE TREES"

Large 40'

Bur Oak	*Quercus macrocarpa*
Chinkapin Oak	*Quercus muehlenbergii*
Escarpment Live Oak	*Quercus fusiformis 'Quartz Mountain'*
American Elm	*Ulmus americana 'Wolf Creek'*
Colorado Blue Spruce	*Picea pungens*

Medium 25'-40'

Western Soapberry	*Sapindus drummondii*
Rocky Mountain Juniper	*Juniperus scopulorum*
Eastern Red Cedar	*J. virginiana*
Alligator Juniper	*J. deppeana*
Rocky Mountain White Oak	*Quercus gambelii*

Small 25'

Mohr Oak	*Quercus mohriana*
Pinchot Juniper	*Juniperus pinchotii*
Pinyon	*Pinus edulis*
Mountain Mahogany	*Cercocarpus montanus var. argentea*
One-seed Juniper	*Juniperus monosperma*

5 TREES "WORTH PLANTING"

Blue Douglas Fir	*Pseudotsuga menziesii var. glauca*
Rocky Mountain Ponderosa Pine	*Pinus ponderosa var. scopulorum*
Southern Sugar Maple	*Acer floridanum 'Caddo'*
Knowlton Hop-Hornbeam	*Ostrya knowltonii*
Prairie Flameleaf Sumac	*Rhus lanceolata*

5 TREES "TO PLANT LESS OF"

Box Elder	*Acer negundo*
Tree of Heaven	*Ailanthus altissima*
Siberian Elm	*Ulmus pumila*
Fruitless Mulberry	*Morus alba 'Fruitless'*
Black Locust	*Robinia pseudoacacia*

TREES FOR TEXAS

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Wild Flowers of the Big Thicket, east Texas and western Louisiana. Geyata Ajilvsgi, Texas A & M University Press, College Station, 1979.

Texas Trees A Friendly Guide. Paul W. Cox and Patty Leslie, Corona Publishing Company, San Antonio, 1988.

Trees, Shrubs and Woody Vines of east Texas, E. S. Nixon, Bruce Lyndon Cunningham Productions, Nacogdoches, 1985.

How to Grow Native Plants of Texas and the Southwest, Jill Nokes, Texas Monthly Press, Austin, 1986.

Trees and Shrubs of Trans-Pecos Texas, A. M. Powell, Big Bend Natural History Association, Big Bend National Park, 1988.

The Oaks of Texas, Benny J. Simpson, Journal of Arboriculture 12(12): 302-304, 1986.

A Field Guide to Texas Trees, Benny J. Simpson, Tex. Mo. Press, Austin, 1988.

Texas Native Tree and Plant Directory, Texas Department of Agriculture, 1988.

A Practical Guide to Edible and Useful Plants, Delena Tull, Tex. Mo. Press, Austin, 1987.

Trees, Shrubs and Woody Vines of the Southwest, R. A. Vines, University of Texas, Austin, 1960.

Wildflowers of the Big Bend Country, Texas, B.H. Warnock, SRSU, Alpine, 1974.

Wildflowers of the Guadalupe Mountains and Sand Dune Country, Texas, B. H. Warnock, SRSU, Alpine, 1974.

Wildflowers of the Davis Mountains and the Marathon Basin, Texas, B.H. Warnock, SRSU, Alpine, 1977.

Landscaping with Native Texas Plants, Sally Wasowski and Julie Ryan, Tex. Mo. Press, Austin, 1985.

Native Texas Plants, Landscaping Region by Region, Sally Wasowski with Andy Wasowski, 1988.

Compiled by: Benny J. Simpson, Research Scientist, The Texas Agricultural Experiment Station, Texas A&M University System.

TREES FOR UTAH

16 "TRIED AND TRUE TREES"

Large 40'

Norway Maple	*Acer platanoides*
Bur Oak	*Querqus macrocarpa*
Littleaf Linden	*Tilia cordata*
Pagoda Tree	*Saphora japonica*
Common Hackberry	*Celtis occidentalis*

Medium 25'-40'

Callery Pear	*Pyrus calleryana cvs*
Panicled Golden Raintree	*Koelreuteria paniculata*
Fruitless Mulberry	*Morus alba 'Kingman'*
Amur Maple	*Acer ginnala*
Red Horsechestnut	*Aesculus x carnea 'Brioti'*

Small 25'

Lavalle Hawthorne	*Crataegus x lavallei*
Washington Hawthorne	*Crataegus phaenopyrum*
Eastern Redbud	*Cercis canadensis*
Bechtel Crabapple	*Malus ioensis 'Plena'*
Newport Flowering Plum	*Prunus cerasifera 'Newport'*
Bigtooth Maple	*Acer grandidentatum*

17 TREES "WORTH TRYING"

Korean Mountain Ash	*Sorbus alnifolia*
Hardy Rubber Tree	*Eucomacia ulmoides*
Lacebark Elm	*Ulmus parvifolia*
Silver Linden	*Tilia tomentosa*
Turkish Filbert	*Corylus colurna*
Bald Cypress	*Taxodium distichua*
Western Yellowwood	*Cladrastis lutea*
Kentucky Coffeetree	*Gymnocladus dioicus*
Shumard Oak	*Quercus shumardi*
Shingle Bark	*Quercus*
Paperbark Maple	*Acer griseum*
Tatarian Maple	*Acer tataricum*
Upright forms of several species	*Fagus sylvatica*
	Quercus robur
	Ginkgo biloba
	Acer platanoides

10 "TREES TO PLANT LESS OF"

European White Birch	*Betula pendula*
Silver Maple	*Acer saccharinum*
Siberian Elm	*Ulmus pumila*
Thornless Honeylocust	*Gleditsia triacanthos var. inermis*
European Ash	*Fraxinus excelsior*
Pin Oak	*Quercus palustris*
American Elm	*Ulmus americana*
Boxelder	*Acer negundo*
Lombardy Poplar	*Populus nigra 'Italica'*
Russian Olive	*Elaeagnus angustifolia*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

Ornamental and Shade Trees for Utah, A Tree Guide for Intermountain Communities, E. Gregory McPherson and Gregory H. Graves, Cooperative Extension Services, Utah State University, 1984.

Red Butte Gardens and Arboretum, University of Utah, Bldg. 436, Salt Lake City, Utah 84112

Sunset Western Garden Book, Lane Publishing Co., Menlo Park, California

The Complete Trees of North America Field Guide and Natural History, Thomas S. Elias, Outdoor Life/Nature Books, Van Nostrand Reinhold Company, New York 1980

Manual of Cultivated Conifers - hardy in the cold and warm temperature climates, P. Den Ovden, Dr. B.K. Boom, (Martinus Nijhoff/The Hague - Boston - London) 1978

Trees and Shrubs of the Southwestern Deserts, Lyman Benson and Robert A. Darrow, third edition, The University of Arizona Press/ Tucson, 1981

Hilliers Manual of Trees and Shrubs. H.G. Hillier & Sons. A.S. Barnes Co., N.J. 1977

The World of Trees. Orthos Book Series, Chevron Chemical Co. 1977

Manual of Woody Landscape Plants Michael A. Dirr. Stipes Publishing Co., Champaign Illinois, 1977

Hortus Third. Staff of the L.H. Bailey Hortorium, Cornell University, Macmillan, 1976

Common Native Trees of Utah. Carl M. Johnson. Utah State University Cooperative Extension Service. Special Report No. 22., 1970

Landscape Plants from Utah's Mountains. Richard Sutton and Craig W. Johnson, Utah State University, Extension Service, (EC-368). 1974.

Compiled by: W. Richard Hildreth, Director, Red Butte Gardens and Arboretum, University of Utah.

Qualification: This list is limited and should be used in conjunction with the referenced sources.

TREES FOR WYOMING

RECOMMENDED DECIDUOUS TREES

		Varieties
Green Ash	*Fraxinus pennsylvanica*	Marshall's Summit Patmore Burgeson
Thinleaf Alder	*Alnus tenuifolia*	
White Birch	*Betula pendula*	Cutleaf Weeping
Common Catalpa	*Catalpa bignonioides*	
Western Catalpa	*Catalpa speciosa*	
Eastern Cottonwood	*Poplar deltoides*	Nor'easter Platte
Narrowleaf Cottonwood	*Poplar angustifolia*	
Balsam Cottonwood	*Poplar balsamifera*	
Aspen Cottonwood	*Poplar tremuloides*	
Crab Apple 'Dolgo'	*Malus adstringens*	Dolgo
Common Hackberry	*Celtis occidentalis*	
Western Hackberry	*Celtis reticulata*	
Washington Hawthorn	*Cratagus phaenopyrum*	
Canadian Hybrid Hawthorn	*Cratagus toba*	
Honeylocust	*Gleditsia triacanthos var. inermis*	Imperial Shademaster Skyline
Kentucky Coffee Tree	*Gymnocladus dioica*	
American Linden	*Tilia americana*	
Crimean Linden	*Tilia euchlora*	
Littleaf Linden	*Tilia cordata*	Greenspire
Amur Maple	*Acer ginnala*	
Norway Maple	*Acer platanoides*	Globosum Cleveland Emerald Queen Schwedler
Red Maple	*Acer rubrum*	
European Mountain Ash	*Sorbus aucuparia*	
Curlleaf Mountain Mahogany	*Cercocarpus ledifolius*	
Bur Oak	*Quercus macrocarpa*	
Bradford Callery Pear	*Pyrus calleryana*	Bradford
Canadian Red Cherry	*Prunus virginia melanorarpa*	Shubert
Mayday Tree	*Prunus padus*	
Native American Plum	*Prunus americana*	
Purple Leaf Plum	*Prunus cistena*	Newport
Russian Olive	*Elaeagnus angustifolia*	
Peachleaf Willow	*Salix amygdaloides*	Diamond
Other Willows	*Salix*	Golden Laurel Weeping

RECOMMENDED EVERGREEN TREES

White Fir	*Abies concolor*
Douglas-fir	*Pseudotsuga menziesii*
Eastern Red Cedar	*Juniperus virginiana*
Rocky Mountain Juniper	*Juniperus scopulorum*
Utah Juniper	*Juniperus osteosperma*
Austrian Pine	*Pinus nigra*
Bristlecone Pine	*Pinus aristata*
Limber Pine	*Pinus flexilis*
Pinyon Pine	*Pinus edulis*

Ponderosa Pina	*Pinus ponderosa*
Scotch Pine	*Pinus sylvestris*
Lodgepole Pine	*Pinus contorta*
Blue Spruce	*Picea pungens*
Black Hills Spruce	*Picea glauca 'Densata'*
Engelmann Spruce	*Picea engelmannii*

Build your own urban tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Compiled by: Dan Perko, State of Wyoming, Forestry Division, 1100 West 22nd Street, Cheyenne, Wyoming 82002.

Qualification: This is a list of suggested trees for planting in Wyoming. All trees will not grow in all parts of the state. Some require extra water or planting in areas of high water tables, others are drought tolerant. Elevational requirements must also be considered. For additional information contact the Wyoming State Forestry Division, County Agricultural Extension Agent or Soil Conservation District Office.

TREES FOR EASTERN WASHINGTON

RECOMMENDED STREET TREES

Large 50'-70'

Sycamore Maple	*Acer pseudoplatanus*
Ginkgo	*Ginkgo biloba*
Honey Locust (Shade Master)	*Gleditsia triacanthos inermis*
Scarlet Oak	*Quercus coccinea*

Medium 25'-50'

Hedge Maple	*Acer campestre*
Goldenrain Tree	*Koelreuteria paniculata*
Lavelle Hawthorne	*Crataegus lavellei*
Flowering Plums	*Prunus cerasifera*
Flowering Cherries	*Prunus spp.*
Sugar Maple	*Acer saccharum*

Small 25'

Amur Maple	*Acer ginnala*
Flowering Dogwood	*Cornus florida*
Columnar Hornbeam	*Carpinus betulus*
Columnar Flowering Cherry	*Prunus serrulata*
Columnar Beech	*Fagus sylvatica*

TREES NOT RECOMMENDED

American Sycamore	*Platanus occidentalis*
Box Elder	*Acer negundo*
Tree of Heaven	*Ailanthus altissima*
Silver Maple	*Acer saccharinum*
Poplar	*Populus alba*
Cottonwood	*Populus deltoides*
Weeping Willow	*Salix spp.*

Build your own community tree selection matrix using the blank forms provided in this manual and the following publications and sources for tree information. Refer to Chapter IX, Tree Selection and Planting, for direction.

Publications and Sources for Tree Information

An Introductory Guide to Community and Urban Forestry in Washington, Oregon and California, by The World Forestry Center in Portland Oregon and Robin Morgan, Urban Forestry Consultant, World Forestry Center, 4032 SW Canyon Road, Portland, Oregon 97221.

The Technical Guide to Community and Urban Forestry in Washington, Oregon and California

The Tree Selection Guide to Community and Urban Forestry in Washington, Oregon and California.

Trees and Shrubs Hardy in the British Isles, W. J. Bean, 8th Ed., Vol. I, II, III, and IV. John Murray Ltd., London, about 800 p. each, 1970.

Manual of Woody Landscape Plants, Michael A. Dirr, Stipes, Champaign, IL. 826 p. 1983.

Sunset Western Garden Book, 5th Ed., Lane Publishing Co., Menlo Park, CA 512 p.

Selecting Trees for the Home Landscape for Tri-Cities, Washington, Marianne C. Ophardt, Area Extension Urban Horticulture Agent, Washington State University, Benton-Franklin Cooperative Extension Agent, April 1989.

Compiled from the following sources provided by David Dietzman, Service Forestry Field Coordinator, Washington State Dept. of Natural Resources

Street Trees for Spokane Washington, "A Guide to Selecting Trees for Street-Side Planting Areas", November 1982. Toni Fitzgerald, The Spokane Ad Hoc Urban Forestry Committee, and

Selecting Trees for the Home Landscape for Tri-Cities, Washington, Marianne C. Ophardt, Area Extension Urban Horticulture Agent, Washington State University, Benton-Franklin Cooperative Extension Agent, April 1989.

Qualification: This list is limited and should be used in conjunction with the referenced sources.

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APPENDIX C

Tree Selection Data For Utah and Southern Idaho*

*Use of these lists could be expanded to communities in other hardiness zones 1-4. Consultation with local references and knowledgeable persons is advised.

RELATIVE TOLERANCE OF SELECTED TREE SPECIES TO SOIL COMPACTION AND OXYGEN DEFICIENCY

Botanical Name	Common Name (Hardiness Zone)
High Tolerance	
Acer platanoides	Norway Maple
Acer saccharinum	Silver Maple
Ailanthus altissima	Tree of Heaven (1-4)
Crataegus phaenopyrum	Washington Hawthorne (1-4)
Fagus sylvatica	European Beech (1-3)
Fraxinus americana	White Ash (1-4)
Ginkgo biloba	Ginkgo (1-3)
Gleditsia triacanthos inermis	Thornless Honey Locust (1-4)
Malus spp.	Crabapples (1-4)
Morus alba 'Kingan' and 'Fan-San'	Mulberry (1-3), (4)
Platanus acerifolia	London Plane Tree (2-4)
Populus spp.	Poplars (1-4)
Salix spp.	Willows (1-4)
Sophora japonica	Japanese Pagoda Tree (1-3)
Moderate Tolerance	
Acer campestre	Hedge Maple (1-3)
Acer rubrum	Red Maple (1-3)
Celtis occidentalis	Common Hackberry (1-4)
Crataegus lavellei	Carriere Hawthorne (1-4)
Liquidambar styraciflua	Sweet Gum (2-3)
Prunus cerasifera 'Newport'	Newport Flowering Plum (2-4)
Pyrus calleryana 'Bradford'	Bradford Pear (2-3)
Quercus spp.	Oaks (1-4)
Tilia cordata	Littleleaf Linden (1-4)
Low Tolerance	
Acer saccharum	Sugar Maple (1-3)
Betula papyrifera	Paper Birch (1-3)
Cercis canadensis	Eastern Redbud (1-4)
Robinia idahoensis	Idaho Flowering Locust (1-4)
Sorbus aucuparia	European Mountain Ash (1-4)
Picea spp.	Spruces (1-3)
Thuja occidentalis	American Arborvitae (1-3)

From: Aloys Bernatzky, **Tree Ecology and Preservation**, Elsevier Scientific Publishing Co., Amersterdam, The Netherlands, 1978.

DESIRABLE pH RANGE OF SELECTED TREE SPECIES

Botanical Name	Common Name	Desirable pH Range
Deciduous Trees		
Acer spp.	Maples	6.5-7.5
**Acer saccharinum*	Silver Maple	6.0-7.0
**Acer rubrum*	Red Maple	4.5-7.5
Aesculus glabra	Ohio Buckeye	6.5-7.5
Aesculus hippocastanum	Ho rsechestnut	6.0-7.5
Ailanthus altissima	Tree of Heaven	6.5-7.5
+Catalpa speciosa	Western Catalpa	6.5-8.0
Celtis occidentalis	Common Hackberry	6.5-7.5
Cercis canadensis	Eastern Redbud	6.5-7.5
Crataegus spp.	Hawthorns	6.0-7.5
Fagus sylvatica	European Beech	6.5-7.5
Fraxinus spp.	Ashes	6.0-7.5
Ginkgo biloba	Ginkgo	6.0-6.5
+Gleditsia triacanthos	Honey Locust	6.0-8.0
Gymnocladus dioicus	Kentucky Coffee Tree	6.5-7.5
**Liquidambar styraciflua*	Sweet Gum	6.0-6.5
**Liriodendron tulipifera*	Tulip Tree	6.0-6.5
**Malus spp.*	Crabapples	6.5-7.5
Morus alba	Mulberry	6.5-7.5
Platanus acerifolia	London Plane Tree	6.5-7.5
Populus spp.	Poplars	6.5-7.5
Prunus spp.	Cherrys	6.5-7.5
Pyrus spp.	Pears	6.5-7.5
Quercus alba	White Oak	6.5-7.5
**Quercus borealis*	Red Oak	4.5-6.0
Quercus macrocarpa	Bur Oak	4.0-5.0
Querus robur	English Oak	6.5-7.5
Robinia pseudoacacia	Black Locust	5.0-7.5
Salix spp.	Willows	6.5-7.5
Sophora japonica	Japanese Pagoda	6.0-7.0
**Sorbus aucuparia*	European Mtn. Ash	6.5-7.5
Tilia spp.	Lindens	6.5-7.5
Ulmus parvifolia	Chinese Elm	6.0-7.5
Evergreen Trees		
**Abies concolor*	White Fir	4.0-6.5
Eucalyptus spp.	Eucalyptus	6.5-7.5
Juniperus scopulorum	Rocky Mtn. Juniper	6.5-7.5
Ligustrum lucidum	Glossy Privet	6.0-8.0
Picea spp.	Spruces	4.0-6.5
Picea pungens	Colorado Spruce	6.0-6.5
Pinus spp.	Pines	4.0-7.5
Pseudotsuga menziesii	Douglas Fir	6.0-6.5

*indicates susceptible to chlorosis
+indicates tolerant to saline soils

RELATIVE TOLERANCE OF SELECTED TREE SPECIES TO DE-ICING SALTS

Botanical Name	Common Name (Hardiness Zone)
Highly tolerant	
Acer platanoides	Norway Maple (1-3)
Acer saccharinum	Silver Maple (1-4)
Aesculus hippocastanum	Horsechestnut (1-3)
Celtis occidentalis	Common Hackberry (1-4)
Crataegus phaenopyrum	Washington Hawthorne (1-4)
Elaeagnus angustifolia	Russian Olive (1-4)
Gleditsia triacanthos inermis	Thornless Honey Locust (1-4)
Malus spp.	Crabapples (1-4)
Morus spp.	Mulberry (1-4)
Quercus robur	English Oak (2-3)
Robinia ambigua 'Idahoensis'	Idaho Flowering Locust (1-4)
Sophora japonica	Japanese Pagoda Tree (1-3)
Sorbus aucuparia	European Mountain Ash (1-4)
Abies concolor	White Fir (1-3)
Picea pungens	Colorado Spruce (1-3)
Pinus nigra	Austrian Pine (1-3)
Moderately tolerant	
Acer campestre	Hedge Maple (1-3)
Acer ginnala	Amur Maple (2-3)
Acer rubrum	Red Maple (1-3)
Betula papyrifera	Paper Birch (1-3)
Betula pendula	European White Birch (1-3)
Catalpa speciosa	Western Catalpa (1-4)
Fraxinus americana	White Ash (1-4)
Fraxinus pennsylvanica lanceolata	Green Ash (1-3)
Populus spp.	Poplars (1-4)
Prunus cerasifera 'Newport'	Newport Flowering Plum (2-4)
Pyrus calleryana 'Bradford'	Bradford Pear
Salix spp.	Willows (1-4)
Syringa amurensis japonica	Japanese Tree Lilac (1-3)
Tilia spp.	Lindens (1-4)
Picea abies	Norway Spruce (1-3)
Pinus sylvestris	Scotch Pine (1-3)
Pseudotsuga menziesii	Douglas Fir (1-3)
Thuja occidentalis	American Arborvitae (1-3)
Intolerant	
Acer pseudoplatanus	Sycamore Maple (1-3)
Acer saccharum	Sugar Maple (1-3)
Cercis canadensis	Eastern Redbud (1-4)
Fagus sylvatica	European Beech (1-3)
Gymnocladus dioicus	Kentucky Coffee Tree (1-4)
Liquidambar styraciflua	Sweet Gum (2-3)
Liriodendron tulipifera	Tulip Tree (1-4)
Platanus acerifolia	London Plane Tree (2-4)
Quercus borealis	Northern Red Oak (1-3)
Quercus macrocarpa	Bur Oak (1-3)

From: D.W. Beckerson et. al., "A Guide to: Plant Sensitivity to Environnmental Stress". **Landscape Architecture**, 70 (3): May, 1980.

RELATIVE TOLERANCE OF SELECTED TREE SPECIES TO AIR POLLUTANTS

Botanical Name	Common Name (Hardiness Zone)
Relative tolerance to Sulfur Dioxide	
Highly Tolerant	
Acer platanoides	Norway Maple (1-3)
Acer saccharinum	Silver Maple (1-4)
Acer saccharum	Sugar Maple (1-3)
Ginkgo biloba	Ginkgo (1-3)
Platanus acerifolia	London Plane Tree (2-4)
Populus canadensis	Carolina Poplar (1-4)
Quercus borealis	Northern Red Oak (1-3)
Quercus gambelii	Gambel Oak (1-4)
Tilia cordata	Littleleaf Linden (1-4)
Abies concolor	White Fir (1-3)
Juniperus scopulorum	Rocky Mountain Juniper (1-4)
Picea pungens	Colorado Spruce (1-3)
Pinus flexilis	Limber Pine (1-3)
Thuja occidentalis	American Arborvitae (1-3)
Moderately Tolerant	
Acer rubrum	Red Maple (1-3)
Catalpa speciosa	Western Catalpa (1-4)
Sorbus aucuparia	European Mtn. Ash (1-4)
Tilia americana	American Linden (1-4)
Pinus nigra	Austrian Pine (1-3)
Pinus ponderosa	Ponderosa Pine (1-3)
Pseudotsuga menziesii	Douglas Fir (1-3)
Intolerant	
Betula spp.	Birches (1-3)
Fraxinus americana	White Ash (1-4)
Fraxinus pennsylvanica lanceolata	Green Ash (1-3)
Populus nigra 'Italica'	Lombardy Poplar (1-4)
Ulmus parvifolia	Chinese Elm (2-4)
Relative Tolerance to Ozone	
Highly Tolerant	
Acer platanoides	Norway Maple (1-3)
Acer rubrum	Red Maple (1-3)
Acer saccharum	Sugar Maple (1-3)
Betula spp.	Birches (1-3)
Fagus sylvatica	European Beech (1-3)
Quercus spp.	Oaks (1-3)
Tilia spp.	Lindens (1-4)
Abies concolor	White Fir (1-3)
Picea spp.	Spruces (1-3)
Pseudotsuga menziesii	Douglas Fir (1-3)
Thuja occidentalis	American Arborvitae (1-3)

Moderately Tolerant

Cercis canadensis	Eastern Redbud (1-4)
Liquidambar styraciflua	Sweet Gum (2-3)
Ulmus parvifolia	Chinese Elm (2-4)
Pinus sylvestris	Scotch Pine (1-3)

Intolerant

Ailanthus altissima	Tree of Heaven (1-4)
Fraxinus americana	White Ash (1-4)
Fraxinus pennsylvanica lanceolata	Green Ash (1-3)
Gleditsia triacanthos inermis	Thornless Honey Locust (1-4)
Liriodendron tulipifera	Tulip Tree (1-4)
Sorbus aucuparia	European Mtn. Ash (1-4)
Pinus nigra	Austrian Pine (1-3)
Pinus ponderosa	Ponderosa Pine (1-3)

Relative tolerance to Fluorines

Tolerant

Acer campestre	Hedge Maple (1-3)
Acer platanoides	Norway Maple (1-3)
Gleditsia triacanthos inermis	Thornless Honey Locust (1-4)
Quercus spp.	Oaks (1-3)
Robinia ambigua 'Idahoensis'	Idaho Flowering Locust (1-4)
Salix spp.	Willows (1-4)
Juniperus scopulorum	Rocky Mountain Juniper (1-4)
Thuja occidentalis	American Arborvitae (1-3)

Intolerant

Betula spp.	Birches (1-3)
Fagus sylvatica	European Beech (1-3)
Fraxinus spp.	Ashes (1-4)
Malus spp.	Crabapples (1-4)
Pyrus calleryana 'Bradford'	Bradford Pear (2-3)
Tilia cordata	Littleleaf Linden (1-4)
Abies concolor	White Fir (1-3)
Picea spp.	Spruces (1-3)
Pinus nigra	Austrian Pine (1-3)
Pinus sylvestris	Scotch Pine (1-3)

From: D.W.Beckerson et.al., "A Guide to: Plant Sensitivity to Environmental Stress". **Landscape Architecture**, 70 (3): May, 1980.

HARDINESS ZONES OF TREES ADAPTED TO SOILS IN THIS REGION

(See hardiness zone map, Section VIII, Project Site Evaluation)

Trees Hardy In All Zones (Zones 1-4)

Deciduous Trees

Acer glabrum	Rocky Mtn. Maple
Acer saccharinum	Silver Maple
Ailanthus altissima	Tree of Heaven
Betula occidentalis	Western Water Birch
Catalpa speciosa	Western Catalpa
Celtis occidentalis	Common Hackberry
Cercis canadensis	Eastern Redbud
Crataegus spp.	Hawthorne spp.
Elaeagnus angustifolia	Russian Olive
Fraxinus americana	White Ash
Gleditsia triacanthos inermis	Thornless Honey Locust
Gymnocladus dioicus	Kentucky Coffee Tree
Liriodendron tuplipifera	Tulip Tree
Malus spp.	Crabapples
Prunus padus commutata	May Day Tree
Quercus gambelii	Gambel Oak
Rhamnus frangula columnaris	Tallhedge Buckthorn
Robinia ambigua 'Idahoensis'	Idaho Flowering Locust
Salix spp.	Willows
Sorbus aucuparia	European Mtn. Ash
Tilia americana	American Linden
Tilia cordata	Littleleaf Linden
Tilia euchlora	Crimean Linden

Evergreen Trees

Juniperus scopulorum cvs.	Rocky Mtn. Junipers

Trees Hardy In Zones 1-3 But Not In Zone 4

Deciduous Trees

Acer campestre	Hedge Maple
Acer platanoides	Norway Maple
Acer pseudoplatanus	Sycamore Maple
Acer rubrum	Red Maple
Acer saccharum	Sugar Maple
Aesculus spp.	Horsechestnuts
Betula papyrifera	Paper Birch
Betula pendula	European White Birch
Fagus sylvatica	European Beech
Fraxinus pennsylvanica lanceolata	Green Ash
Gingko biloba	Ginkgo
Morus alba 'Kingan'	Kingan Mulberry
Quercus borealis	Northern Red Oak
Quercus macrocarpa	Bur Oak
Sophora japonica	Japanese Pagoda Tree
Syringa amurensis japonica	Japanese Tree Lilac

Evergreen Trees

Abies concolor	White Fir
Picea abies	Norway Spruce
Picea pungens	Colorado Spruce
Pinus edulis	Pinyon Pine
Pinus flexilis	Limber Pine
Pinus nigra	Austrian Pine
Pinus Ponderosa	Ponderosa Pine
Pinus sylvestris	Scotch Pine
Pseudotsuga menziesii	Douglas Fir
Thuja occidentalis	American Arborvitae

Trees Hardy in Zones 2-4 but Too Tender to Grow in Zone 1

Deciduous Trees

Albizzia julibrissin	Silk Tree
Platanus acerifolia	London Plane Tree
Prunus cerasifera 'Newport'	Newport Plum
Ulmus parvifolia	Chinese Elm

Evergreen Trees

Pinus thunbergiana	Japanese Black Pine

Trees Hardy in Zones 2 and 3 but Cannot Withstand the Extreme Low Temperatures of Zone 1 Nor the Hot, Dry Conditions of Zone 4

Deciduous Trees

Acer ginnala	Amur Maple
Koelreuteria paniculata	Golden Rain Tree
Liquidambar styraciflua	Sweet Gum
Pyrus calleryana 'Bradford'	Bradford Pear
Quercus robur	English Oak

Trees Hardy in Zone 4 Only

Deciduous Trees

Fraxinus holotricha 'Moraine'	Moraine Ash
Fraxinus velutina 'Modesto'	Modesto Ash
Melia azederach	Chinaberry
Morus alba 'Fan-San'	Fan-San Mulberry
Populus fremontii	Fremont Poplar
Zizyphus jujaba	Chinese Date

Evergreen Trees

Eucalyptus polyanthemos	Silver Dollar Tree
Ligustrum lucidum	Glossy Privet
Eriobotrya japonica	Loquat
Pinus halepensis	Aleppo Pine
Pinus pinea	Italian Stone Pine

SELECTED DROUGHT TOLERANT TREE SPECIES

Botanical Name	Common Name (Hardiness Zone)
Deciduous Trees	
Ailanthus altissima	Tree of Heaven (1-4)
Catalpa speciosa	Western Catalpa (1-4)
Celtis occidentalis	Common Hackberry (1-4)
Elaeagnus angustifolia	Russian Olive (1-4)
Koelreuteria paniculata	Golden Raintree (2-3)
Melia azederach	Chinaberry (4)
Morus alba 'Fan-San'	Fan-San Mulberry (4)
Morus alba 'Kingan'	Kingan Mulberry (1-3)
Populus fremontii	Fremont Poplar (4)
Quercus gambelii	Gambell Oak (1-4)
Robinia idahoensis	Idaho Flowering Locust (1-4)
Zizyphus jujuba	Chinese Date (4)
Evergreen Trees	
Eucalyptus polyanthemos	Silver Dollar Tree (4)
Eriobotrya japonica	Loquat (4)
Juniperus scopulorum	Rocky Mtn. Juniper (1-4)
Pinus edulis	Pinyon Pine (1-3)
Pinus flexilis	Limber Pine (1-3)
Pinus halepensis	Aleppo Pine (4)
Pinus nigra	Austrian Pine (1-3)
Pinus ponderosa	Ponderosa Pine (1-3)

SELECTED UTILITY TREE SPECIES

(can adapt to a wide range of adverse growing conditions)

Botanical Name	Common Name (Hardiness Zone)
Deciduous Trees	
Acer campestre	Hedge Maple (1-3)
Ailanthus altissima	Tree of Heaven (1-4)
Catalpa speciosa	Western Catalpa (1-4)
Celtis occidentalis	Common Hackberry (1-4)
Crataegus spp.	Hawthorns (1-4)
Elaeagnus angustifolia	Russian Olive (1-4)
Ginkgo biloba	Ginkgo (1-3)
Gymnocladus dioicus	Kentucky Coffee Tree (1-4)
Koelreuteria paniculata	Golden Rain Tree (2-3)
Melia azedarach	Chinaberry (4)
Morus spp.	Mulberry (1-4)
Robinia ambigua 'Idahoensis'	Idaho Flowering Locust (1-4)
Rhamnus spp.	Buckthorns (1-4)
Zizyphus jujuba	Chinese Date (4)
Evergreen Trees	
Eriobotrya japonica	Loquat (4)
Eucalyptus spp.	Eucalyptus (4)
Juniperus spp.	Junipers (1-4)
Pinus spp.	Pines (1-4)

RELATIVE SENSITIVITY OF SELECTED TREE SPECIES TO SECURITY LIGHTING

Botanical Name	Common Name (Hardiness Zone)
Insensitive	
Liquidambar styraciflua	Sweet Gum (2-3)
Pinus nigra	Austrian Pine (1-3)
Pyrus calleryana 'Bradford'	Bradford Pear (2-3)
Moderately Insensitive	
Acer rubrum	Red Maple (1-3)
Ginkgo biloba	Ginkgo (1-3)
Gleditsia triacanthos inermis	Thornless Honey Locust (1-4)
Koelreuteria paniculata	Golden Rain Tree (2-3)
Sophora japonica	Japanese Pagoda Tree (1-3)
Tilia cordata	Littleleaf Linden (1-4)
Sensitive	
Acer platanoides	Norway Maple (1-3)
Betula papyrifera	Paper Birch (1-3)
Catalpa speciosa	Western Catalpa (1-4)
Platanus acerifolia	London Plane Tree (2-4)
Ulmus americana	American Elm (1-3)
Zelkova serrata	Zelkova (2-3)

From: M. Quigley, "Lighting the Landscape". M.L.A. thesis, Utah State University, Logan, Utah, 1979.

PERCENTAGE OF AVAILABLE SOLAR RADIATION TRANSMITTED THROUGH THE LEAF CANOPY OF SELECTED TREES

Botanical Name	Common Name	Percentage Sunlight Transmitted	Hardiness Zone
Dense Canopy Trees			
Acer platanoides	Norway Maple	10%	1-3
Acer saccharinum	Silver Maple	11	1-4
Aesculus hippocastanum	Horsechesnut	8	1-3
Liriodendron tulipifera	Tulip Tree	10	1-4
Platanus acerifolia	London Plane Tree	11	2-4
Celtis occidentalis	Common Hackberry	12	1-4
Crataegus oxyacantha	English Hawthorne	14	1-4
Fraxinus pennsylvanica lanceolata	Green Ash	13	2-4
Ginkgo biloba	Ginkgo	16	1-3
Gymnocladus dioicus	Kentucky Coffee Tree	14	1-4
Koelreuteria paniculata	Golden Rain Tree	13	2-3
Malus spp.	Crabapples	15	1-4
Tilia cordata	Littleleaf Linden	13	1-4
Open Canopy Tree			
Betula pendula	European White Birch	20	1-3
Crataegus phaenopyrum	Washington Hawthorne	24	1-4
Gleditsia triacanthos inermis	Thornless Honey Locust	30	1-4
Sophora japonica	Japanese Pagoda Tree	24	1-3

From: E.G. McPherson, "The Use of Trees for Solar Control in Utah". Technical Report submitted to Western Sun, Logan, Utah, 1981.

SELECTED TREES AND SHRUBS FOR USE AS WINDBREAKS

Botanical Name	Common Name
Conifers	
Abies concolor	White Fir (1-3)
Ligustrum lucidum	Glossy Privet (4)
Picea pungens	Colorado Spruce (1-3)
Pinus edulis	Pinyon Pine (1-3)
Pinus flexilis	Limber Pine (1-3)
Pinus halapensis	Aleppo Pine (4)
Pinus nigra	Austrian Pine (1-3)
Pinus sylvestris	Scotch Pine
Pinus thunbergiana	Japanese Black Pine (4)
Pseudotsuga menziesii	Douglas Fir (1-3)
Deciduous Trees	
Acer campestre	Hedge Maple (1-3)
Celtis occidentalis	Common Hackberry (1-4)
Elaeagnus angustifolia	Russian Olive (1-4)

Fraxinus pennsylvanica	Green Ash (1-3)
Fraxinus velutina 'Modesto'	Modesto Ash (4)
Morus alba	White Mulberry
Populus spp.	Poplars, Cottonwood (1-4)
Robinia pseudoacacia	Black Locust (1-4)
Zizyphus jujuba	Chinese Date (4)

Deciduous Shrubs

Berberis mentorensis	Mentor Barberry (1-4)
Caragana arborescens	Siberian Pea Shrub (1-4)
Cornus stolonifera	Dogwood (1-4)
Ligustrum vulgare	European Privet (1-4)
Lonicera spp.	Honeysuckle (1-4)
Pyracantha coccinea	Firethorn (1-4)
Rhamnus cathartica	Buckthorn (1-4)
Rhus trilobata	Fragrant Sumac (1-4)
Viburnum opulus	European Cranberry (1-4)

SELECTED PLANTS SUITABLE FOR SCREENING

Botanical Name	**Common Name**
Abies concolor	White Fir (1-3)
Caragana arborescens	Siberian Pea Shrub (1-4)
Cotoneaster acutifolia	Peking Cotoneaster (1-4)
Crataegus spp.	Hawthorns (1-4)
Eucalyptus spp.	Eucalyptus (4)
Euonymous europaeus	European Euonymous (1-4)
Juniperus spp.	Junipers (1-4)
Ligustrum spp.	Privets (1-4)
Lonicera spp. (shrub type)	Honeysuckles (1-4)
Mahonia aquifolium	Oregon Grape Holly (2-3)
Picea spp.	Spruces (1-3)
Pinus spp.	Pines (1-4)
Prunus spp.	Cherrys (2-4)
Pseudotsuga menziesii	Douglas Fir (1-4)
Pyracantha spp.	Firethorns (1-4)
Rhamnus frangula columnaris	Tallhedge (1-4)
Rhus spp.	Sumacs (1-4)
Taxus spp.	Yews (2-3)
Thuja occidentalis	American Arborvitae
Viburnum spp.	Viburnums (1-3)

SELECTED PLANTS FOR EROSION CONTROL

Botanical Names	**Common Name (Hardiness Zone)**
Arctostaphylos uva-ursi	Bearberry (1-4)
Atriplex spp.	Saltbush (1-4)
Chaenomeles spp.	Quinces (1-4)
Cotoneaster spp.	Cotoneasters (1-4)
Elaeagnus angustifolia	Russian Olive (1-4)
Euonymus fortunei	Wintercreeper (1-4)
Forsythia spp.	Forsythia (2-4)
Juniperus spp.	Junipers (1-4)
Lonicera japonica	Honeysuckle (1-4)

Mahonia repens	Creeping Mahonia (2-3)
Parthenocissus quinquefolia	Virginia Creeper (1-4)
Pyracantha spp.	Firethorns
Rhus spp.	Sumacs (1-4)
Rosa spp.	Roses (1-4)
Vinca minor	Periwinkle (1-3)

RELATIVE MAINTENANCE REQUIREMENTS OF SELECTED TREE SPECIES

Botanical Name	**Common Name (Hardiness Zone)**
Low Maintenance Requirement	
Acer campestre	Hedge Maple (1-3)
Acer ginnala	Amur Maple (1-3)
Acer glabrum	Rocky Mt. Maple (1-4)
Cercis canadensis	Eastern Redbud (1-4)
Ginkgo biloba	Ginkgo (1-3)
Gymnocladus dioicus	Kentucky Coffee Tree (1-4)
Juniperus spp.	Junipers (1-4)
Koelreuteria paniculata	Golden Rain Tree (2-3)
Liquidambar styraciflua	Sweet Gum (2-3)
Melia azedarach	Chinaberry (4)
Pseudotsuga menziesii	Douglas Fir (1-4)
Pyrus calleryana 'Bradford'	Bradford Pear (2-3)
Quercus spp.	Oaks (1-3)
Sophora japonica	Japanese Pagoda Tree (1-3)
Ulmus parvifolia	Chinese Elm (2-4)
Average Maintenance Requirement	
Acer platanoides	Norway Maple (1-3)
Acer rubrum	Red Maple (1-3)
Acer saccharum	Sugar Maple (1-3)
Albizzia julibrissin	Silk Tree (2-4)
Celtis occidentalis	Common Hackberry (1-4)
Crataegus spp.	Hawthorns (1-4)
Eriobotrya japonica	Loquat (4)
Elaeagnus angustifolia	Russian Olive (1-4)
Eucalyptus polyanthemos	Silver Dollar Tree (4)
Fagus sylvatica	European Beech (1-3)
Fraxinus spp.	Ashes (1-4)
Gleditsia triacanthos inermis	Honey Locust (1-4)
Lagerstroemia indica	Crape Myrtle (4)
Ligustrum lucidum	Glossy Privet (4)
Liriodendron tulipifera	Tulip Tree (1-4)
Malus spp.	Crabapples (1-4)
Morus alba (fruitless varieties)	Mulberry (1-4)
Nerium oleander	Oleander (4)
Picea spp.	Spruces (1-3)
Pinus spp.	Pines (1-4)
Platanus acerifolia	London Plane Tree (2-4)
Prunus spp.	Cherry (1-4)
Robinia ambigua 'Idahoensis'	Idaho Flowering Locust (1-4)
Sorbus aucuparia	European Mt. Ash (1-4)
Syringa amurensis japonica	Japanese Tree Lilac (1-3)
Thuja occidentalis	American Arborvitae
Tilia spp.	Lindens (1-4)
Zizyphus jujuba	Chinese Date (4)

High Maintenance Requirement

Acer saccharinum	Silver Maple (1-4)
Aesculus spp.	Horsechestnuts (1-3)
Ailanthus altissima	Tree of Heaven (1-4)
Betula spp.	Birches (1-3)
Catalpa speciosa	Western Catalpa (1-4)
Populus spp.	Poplars (1-4)
Rhamnus spp.	Buckthorns (1-4)
Salix spp.	Willows (1-4)

APPENDIX D

Plants That Provide Resources for Wildlife

PLANTS THAT PROVIDE RESOURCES FOR WILDLIFE

Note: Common names according to Welsh, Stanley L., *et al.* 1987. A Utah Flora. Provo, Utah: Brigham Young University.

Native and Naturalized Ground Covers

PLANT NAME	WILDLIFE VALUE	SEASON
BEARBERRY *Arctostaphylos uva-ursi*	Red berries provide food for birds, deer	fall
BUCKWHEAT, MAT *Eriogonum caespitosum*	food for seed-eating birds, small mammals	fall, winter
BUNCHBERRY *Cornus canadensis*	fruit for birds, small mammals	fall
CACTUS, PRICKLY PEAR AND CHOLLA *Opuntia spp.*	fruit, seeds, and nesting cover for birds; food and cover for small mammals	all
GRAPE, OREGON *Mahonia repens*	food for grouse, deer	all
SAGEBRUSH, FRINGED *Aremisia frigida*	food for sage grouse, cover for rodents	all
VIRGIN'S-BOWER, WHITE *Clematis ligusticifolia*	food and cover for birds, small mammals	all

Native and Naturalized Perennial Grasses

PLANT NAME	WILDLIFE VALUE	SEASON
BLUESTEM, SAND *Andropogon hallii*	seed for birds and small mammals	summer, fall
BUFFALOGRASS *Buchloe dactyloides*	seed for birds and small mammals	summer, fall
GRAMA, BLUE *Bouteloua gracilis*	seed for birds and small mammals; stems and leaves eaten by many mammals	summer, fall
RICEGRASS, INDIAN *Oryzopsis hymenoides*	seed for birds and small mammals	summer, fall
WHEATGRASS, INTERMEDIATE *Agropyron intermedium*	food for upland game birds; small and large mammals	summer, fall

Ornamental Groundcovers and Vines

NAME	WILDLIFE VALUE	SEASON
CREEPER, VIRGINIA *Parthenocissus quinquefolia*	fruit and cover for birds	fall, winter
HONEYSUCKLE *Lonicera ciliosa or sempervirons*	nectar, fruit, and nesting cover	spring, summer

TRUMPET-VINE *Campsis radicans*	nectar	summer

Native and Naturalized Shrubs

PLANT NAME	WILDLIFE VALUE	SEASON
BITTERBRUSH *Purshia tridentata*	deer browse	winter
BUFFALOBERRY, SILVER *Shepherdia argentea*	fruit for birds, small mammals	summer
CORALBERRY *Symphoricarpos orbiculatus*	flowers for nectar-feeders; fruit for birds, small mammals	spring, summer, fall
CURRANT, GOLDEN *Ribes aureum*	very important bird food and cover plant	summer
DOGWOOD, RED-OSIER *Cornus sericea*	important food plant for birds	summer, fall, winter
ELDERBERRY *Sambucus spp.*	excellent food plant for birds, small and large mammals	summer, fall
HAWTHORN, RIVER *Crataegus douglasii*	nesting cover and fruit for birds	all
INDIGO, FALSE *Amorpa fruticosa*	excellent butterfly nectar plant	summer
MAHOGANY, ALDER-LEAF MOUNTAIN *Cercocarpus montanus*	deer winter browse, fruit for birds, small mammals	all
MAHONIA, SHINING *Mahonia aquifolium*	fruit for birds	fall, winter
MANZANITA, GREENLEAF *Arctostaphylos patula*	fruit for blue grouse, deer	fall, winter
RABBITBRUSH, RUBBER *Chrysothamnus nauseosus*	deer browse	all
ROSE, WOODS *Rosa woodsii*	fruit for deer, birds, small mammals; cover	all
SAGEBRUSH, BIG *Aremisia tridentata*	deer browse; seed for birds	all
SALTBUSH, BIG *Atriplex lentiformis*	excellent cover for quail and small desert mammals; seeds persist into winter	all
SERVICEBERRY *Amelanchier spp.*	deer; important early fruit for birds	all
SNOWBERRY, WHITE *Symphoricarpos albus*	deer; fruit for birds, small mammals	all
SKUNKBUSH *Rhus aromatica var. trilobata*	fruit, cover for birds, small mammals	all

WINTERFAT *Ceratoides lanata*	important winter food for desert birds and animals	fall, winter

Ornamental Shrubs

PLANT NAME	WILDLIFE VALUE	SEASON
BARBERRY, THUNBERG *Berberis thunbergii*	nesting sites, cover	all
BUCKTHORN *Rhamnus spp.*	fruit	late summer
BUTTERFLY BUSH *Buddleia davidii*	nectar for hummingbirds, butterflies	summer
COTONEASTER, ROCK AND PEKING *Cotoneaster horizontalis and C. acutifolius*	fruit for birds	fall, winter
DAY-LILY *Hemerocallis fulva*	nectar for hummingbirds, orioles	summer
FIRETHORN *Pyracantha coccinea*	fruit for birds; nesting cover	fall, winter
HONEYSUCKLE, TATARIAN *Lonicera tatarica*	nectar and fruit for birds	summer
JUNIPER *Juniperus spp.*	winter food, nesting sites	winter, spring
RASPBERRY, BLACKBERRY, AND THIMBLEBERRY *Rubus spp.*	nesting cover; food	spring, summer
SAND CHERRY, WESTERN *Prunus besseyi*	fruit for birds	summer
WEIGELA *Weigela florida*	nectar for bees, moths, hummingbirds	early summer

Native and Naturalized Trees

PLANT NAME	WILDLIFE VALUE	SEASON
ALDER *Alnus spp.*	seed for birds; cover and nest sites	all
BIRCH, WATER *Betula occidentalis fontinalis*	seed for birds; deer browse	all
BOXELDER *Acer negundo* (select female for seeds)	seeds and insects for birds and squirrels, deer; soft wood for nesting cavities	all
CHOKECHERRY *Prunus virginiana*	fruit and nesting cover; deer and elk browse	all

COTTONWOOD, FREMONT *Populis fremontii*	birds eat buds; soft wood for nesting cavities	all
FIR, DOUGLAS *pseudotsuga menziesii*	cover for birds and mammals; food for squirrels, blue grouse	all
FIR, SUBALPINE *Abies lasiocarpa*	food and cover for grouse, squirrel, deer	all
HACKBERRY, NETLEAF *Celtis reticulata*	fruit and nesting cover for birds, mammals	all
JUNIPER, ROCKY MOUNTAIN *Juniperus scopulorum*	food and cover for birds and rodents	all
MAHOGANY, CURL-LEAF MOUNTAIN *Cercocarpus ledifolius*	excellent deer browse	winter, spring
MAPLE, BIGTOOTH *Acer grandidentatum*	supports canopy and ground-feeding birds, deer	all
OAK, GAMBEL *Quercus gambelii*	birds and small mammals eat acorns; deer browse and cover	all
OLIVE, DESERT *Forestiera publescens (neomexicana)*	nectar for bees; fruit for birds. Male plant — flowers; female — berries	spring, early summer
OLIVE, RUSSIAN *Elaeagnus angustifolia*	fruit for birds, nectar for bees, nesting sites	summer, fall
PINE, PONDEROSA *Pinus ponderosa*	seeds and cover for birds, small mammals	all
PINE, SCOTS *Pinus sylvestris*	seeds and cover for birds; small mammals	all
PINYON *Pinus edulis*	seeds and cover for desert birds and animals	all
PLUM, AMERICAN *Prunus americana*	fruit and cover for birds, mammals	summer, fall
SPRUCE, BLUE *Picea pungens*	cover for birds, small and large mammals; food for seed-eating birds, esp. blue growse	all
WILLOW, SWEET DESERT *Chilopsis linearis*	nectar for hummingbirds	summer

Ornamental Trees

PLANT NAME	WILDLIFE VALUE	SEASON
ASH, GREEN *Fraxinus pennsylvania var. lanceolata* (select female for seeds)	seed for birds	fall, winter
CEDAR, RED *Juniperus virginiana*	important winter food and nesting cover	winter, spring
CHERRY, MAY DAY *Prunus padus*	fruit for birds	summer

CRABAPPLE, APPLE *Malus spp.*	fruit for birds; nesting sites	all
HACKBERRY *Celtis occidentalis* (select type with heavier fruiting)	fruit for birds	fall, winter
HAWTHORN WASHINGTON *Crataegus phaenopyrum*	fruit, nesting cover for birds	winter, spring
JUNIPER, COLUMNAR *Juniperus spp.*	fruit and nesting cover	winter, spring
MOUNTAIN-ASH, EUROPEAN *Sorbus acucuparia*	fruit for birds	fall, winter
MULBERRY, RUSSIAN *Morus alba var. tatarica* (select fruiting type)	important food plant for birds	summer, fall
PINE, AUSTRIAN *Pinus nigra*	nest cover	spring
POPLAR, BALSAM *Populus balsamifera*	soft wood for nest cavity excavation	spring

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APPENDIX E

Wellsville City Tabloid

WELLSVILLE COMMUNITY FOREST PROGRAM 1982

OVERVIEW

The Wellsville City Shade Tree and Beautification Commission (formerly the Beautification Committee) has been studying the street and park trees (the community forest) in Wellsville for the past six months. The purpose of this newspaper is to inform you, the citizens of Wellsville, as to what has been learned. The articles in this newspaper describe the varied range of activities and recommendations developed by the Commission as related to the planning and management of the trees in Wellsville. The Commission wants to know your feelings and thoughts about issues related to Wellsville's trees, and hopes that by sharing this information with you, new ideas will arise. If you have any questions, comments, or specific needs, just contact one of the Commission members. They will be happy to listen and discuss any thoughts you have or provide assistance. Their names are listed on the last page of this newspaper.

Street trees along Main Street in Wellsville.

MAY 1st IS ARBOR DAY

Mayor Brenchley recently proclaimed Saturday, May 1 as Arbor Day in Wellsville. In addition to the usual clean-up activities there will be a commemerative tree planting ceremony on the city square.

John Spence, a member of the newly formed Shade Tree and Beautification Commission is organizing this year's tree planting and clean-up program.

Thirty-two trees have been purchased and will be delivered to the city square on Arbor Day. They will be planted around the ball park and in the city square. Volunteers, young and old alike, are encouraged to assist in this effort. Bring extra shovels, wheelbarrows, rakes, and watering cans if available.

This year's clean-up efforts will focus on four areas of Wellsville. Trash and other debris will be collected along the major entry roads into town. Also, efforts will be made to clean-up the city square and Main Street. Exposed areas around the tennis courts will be covered with sod. Interested participants are requested to bring brooms, garbage bags and other items that may be useful.

Refreshments will be served at noon on the city square to those who are actively assisting in the planting and clean-up activities. At that time, Mayor Brenchley and Craig Pettigrew, the Bear River Area Forester, will say a few words and then participate in a commemerative tree planting.

The Farmer's Almanac assures us that the weather will be sunny and warm so take advantage of this opportunity to mingle with friends and at the same time contribute to the beautification of your community.

WELLSVILLE'S CITIZENS WANT MORE TREES

Last November, Dr. Wes Maughan's sociology class from Utah State University, conducted a community survey in Wellsville. The city council approved the survey as a valuable effort to collect information on how the citizens of Wellsville feel about a wide range of local issues. Three questions on the survey dealt with the subject of the community forest. Those questions and the survey results are shown below.

Survey Results

How would you rank the following physical environment conditions in Wellsville?

1. The condition of trees on Wellsville's streets and city parks?

Excellent	9.8%
Good	47.1%
Fair	28.2%
Poor	14.5%
Don't know	.4%

2. More trees on city property?

For	58.8%
Against	20.4%
No opinion	20.8%

3. Would you be willing to join the Tree City U.S.A. Program and contribute $1.00 per capita per year to improve the beautification of Wellsville?

Yes	73.5%
No	26.5%

The survey results of the first question indicate that the majority of Wellsville's citizens believe that on the whole the city's trees are in good or excellent condition. While most of the local trees are in good condition, a recent vegetation inventory conducted by Mark Larsen revealed that 310 of the 833 trees examined had some type of problem. This means that 37% of the city's trees are in immediate need of some type of maintenance. Typical types of maintenance needed to improve the beauty and health of local trees includes the removal of dead and broken branches and spraying to kill borers and other pests.

Nearly two thirds of the residents surveyed felt that more trees should be planted along the streets and in the parks of Wellsville. This suggests that most citizens appreciate the fact that trees improve the beauty and quality of life in their city.

The results of the final question reconfirm the fact that most citizens believe that new tree plantings as well as attractively maintained existing trees are important aspects of Wellsville's beautification efforts. The fact that three out of every four people surveyed are willing to contribute their own money to support a community forest program shows how strongly the citizens of Wellsville feel about their trees and the appearance of their city. The people of Wellsville should take pride in their own and their fellow citizen's willingness to contribute in money and time to the beautification of their city.

Remember! May 1 is Arbor Day.
Plant a Tree.

WELLSVILLE ON THE WAY TO TREE CITY USA

One of the major goals of the Wellsville Shade Tree and Beautification Commission is to meet the standards necessary to make the city eligible for recognition as Tree City USA. This program is designed to recognize communities that are effectively managing their tree resources. The award is not simply for pretty trees, but also for the program that makes them pretty. The Four Tree City USA standards that have to be met and the actions taken by Wellsville to satisfy these requirements are shown below:

Tree City USA Standards

1. Have a legally constituted tree body.
2. Have adopted city ordinances providing for street tree planting, maintenance, and removal according to proper municipal forestry principles.
3. Have an active, comprehensive Community Forestry program, supported by a minimum one dollar per capita public funds.
4. Have a formal Arbor Day proclamation by the Mayor and have a commemorative tree planting each year.

Wellsville's Actions

A Shade Tree and Beautification Commission was established by the City Council.

City Council adopted the Wellsville City Tree Ordinance and the Wellsville Community Forest Plan.

The City Council allocated $2,000.00 to the Commission in 1981 for development of the program.

Major Kent Brenchley declared May 1 as Arbor Day in Wellsville and a commemorative tree planting will be held then.

As you can see, Wellsville is on the way to Tree City USA. The Shade Tree and Beautification Commission have worked hard to reach this goal. You can help this effort by participating in the Arbor Day community planting. The Commission also accepts donations from businesses, industries, and individual citizens to help pay for the costs of purchasing, planting, and maintaining the street and park trees of Wellsville.

WELLSVILLE COMMUNITY FOREST PLAN

The Wellsville Community Forest Plan has been developed by the Shade Tree and Beautification Commission to provide general guidelines for the future selection, arrangement and management of street trees in the public rights-of-way and parks of Wellsville. The Plan consists of two parts, both of which are presented in this tabloid:

1. **A Forest Plan Map** showing a planting pattern for the entire community.
2. **A Forest Plan Report** listing tree species appropriate for planting at locations designated on the Forest Plan Map. The Report also lists the criteria used to make the decisions that led to the planting pattern shown on the map. Program priorities for the short and long term management of Wellsville's Community Forest are noted as well.

Why is a Community Forest Plan Necessary?

There are three good reasons why Wellsville can benefit from a Community Forest Plan. Most of the trees in Wellsville are old, large and beginning to decline in health due to old age and increased susceptability to insects, disease, and storm damage. To perpetuate the community forest for the benefit of the generations to come, ailing trees must be cared for and new trees must be planted to replace those that will have to be removed. The city does not have large sums of money to spend on public trees. What is spent must be spent wisely. The first purpose of the Forest Plan is to determine how limited funds can be most efficiently used for new plantings, the maintenance of existing trees and tree removal.

A second benefit of a Forest Plan is that it can help reduce the costs associated with tree maintenance, removal and replacement due to poor tree selection and location. By insuring that tree species chosen for a given location withstand freezing, are relatively insect and disease resistent, strong wooded, clean, and will not conflict with overhead wires or heave adjacent sidewalks, future tree care and replacement costs can be minimized.

Finally, properly selected trees can reinforce and enhance the character and beauty of Wellsville. For example, the two rows of Green Ash trees along East Main Street make a shady and pleasant entry drive to Wellsville. Their arching and continuous canopy create a leafy wall and ceiling that softens the adjacent landscape and makes a favorable impression on one's perception of the community's attractiveness. This is just one example of how the existing trees in Wellsville contribute to the city's beauty. By carefully selecting and locating new trees throughout the city, the visual and spatial character of Wellsville can be enhanced.

What is the Forest Plan Map?

The Forest Plan Map is shown on page 3. It is a guide to the placement and selection of street and park trees in Wellsville. Its purpose is to reinforce the desirable community pattern elements identified in the community pattern inventory by providing a guiding framework for new plantings. If the Forest Plan Map is adhered to, the "hodge-podge" effects of little trees next to big ones and trees of totally different shapes besides or across from one another can be avoided.

The Forest Plan Map does not specify what tree species should be located at a given spot. Instead it notes what type of trees are desirable. The two factors used to develop the four tree type categories listed in the map's legend are as follows:

1. **Planting Pattern** - This refers to the way trees are arranged in planting strips or parks. A formal planting pattern implies that the trees are equally spaced and planted in a straight line. An informal planting pattern is characterized by random or nonlinear tree placement and a varied amount of space between the trees.
2. **Tree Size** - The Forest Plan identifies four categories of tree size. Large trees grow to be taller than 50 feet. Medium trees reach a mature height of 20 to 50 feet. Small trees are less than 20 feet tall at maturity. A mix of tree sizes indicates that small, medium, and tall trees are interplanted.

Criteria Used to Establish Tree Type Categories

Four tree type categories are shown on the Forest Plan Map. The reasons why these categories are used at different locations throughout Wellsville is explained below.

1. **Formal Large** - A formal planting pattern was selected for street trees of all sizes throughout the residential part of the city except for areas where existing natural vegetation occurs near the road. The formal planting pattern compliments the geometric grid pattern of the streets. Also, most of the existing street trees are formally arranged.

   Large trees have been designated to be planted in a formal pattern around the center three blocks of Wellsville. This area contains the ballpark, businesses, church, tabernacle, school and some homes. Many Wellsville residents, young and old alike, travel to and through this area. The large formal plantings around these blocks indicate that they are the hub of Wellsville.

   Formal large street trees are also suggested for use on the edges of the city where the tall willows and poplars of the hollows meet the formal street pattern of the city. Large trees are not specified in these areas if possible conflicts with overhead wires exist.

2. **Formal Medium** - Medium size trees are considered more desirable than small trees along streets without overhead wires. The larger height and spread of medium sized trees allows for more shading of the street and necessitates the use of fewer trees because they can be spaced further apart than small trees.

   Another concern that led to the designation of many formal medium tree types was the transition from large formal types to smaller trees and from small formal types to larger trees. The goal here was to avoid large and abrupt changes in the size of trees at points where different tree types meet (usually street intersections). Formal medium tree types are appropriate next to large trees to provide a gentle decrease in tree size and next to small trees for a gradual increase in size. However, in some cases the existence of overhead wires did limit the designation of formal medium tree types for use in transitioning between trees of different sizes.

3. **Formal Small** - Formal plantings of small trees are specified along street sides with overhead wires 15 to 25 feet above the ground.

   This will eliminate the "butch cutting" that disfigures medium and large trees that have grown into the wires.

   On many streets, like Center Street, the overhead wires run down one side of the road. The question of whether to plant small trees under the wires and medium trees on the opposite side or small trees on both sides was discussed. The Commission decided that along major streets (designated in the Community Pattern Inventory) formal small tree types should be specified for both sides of the street. This will result in a more balanced and formal effect than if medium sized trees were planted opposite small trees. However, on minor streets it was decided that the economy and other benefits of medium sized trees opposite small trees outweighed the fact that the design may appear unbalanced. This unbalanced effect can be minimized if the small and medium sized trees are similar in form, texture, and color.

4. **Informal Mix** - A mixture of small, medium, and large sized trees in an informal planting pattern is specified for the undeveloped pasture land in the northeast section of Wellsville. The abundant native vegetation combined with the predominantly agricultural land use patterns suggest that a formal planting would appear out of place in these areas. New plantings should blend harmoniously with the existing vegetation.

   The informal mix tree type is also designated for the parks within the city and along streets where native bottomland vegetation exists adjacent to the rights-of-way. The existing informal planting patterns seen in the Town Square and the reservoir area should be maintained and reinforced with new informal plantings of tree species that will grow to a variety of heights. The existing streamside vegetation in the hollows should be complimented in a similar fashion.

How to Use the Forest Plan Map

The four categories of tree types that were just discussed are represented by different tones on the map. Street trees are usually located in the lawn area between the edge of the road and the sidewalk. This area is commonly called a planting strip and is city property. The Forest Plan Map indicates which tree type category is most suitable for each planting strip. The width of the line does not represent the actual width of the planting strip. Also noted on the Forest Plan Map are the tree type categories for park plantings. To illustrate how the Forest Plan Map is used locate Main Street on the map. The grey tones surrounded by wiggly lines to the east of 300 East indicates that a mixture of tree sizes planted in an informal pattern should be located along both sides of Main Street. The next three blocks to the west (300 East to Center Street) have a black tone along both sides of Main Street. Large trees in a formal planting pattern are designated for use here. A formal planting pattern of small trees is indicated by the light grey tone along both sides of Main Street from Center Street to 200 West.

Which Trees to Plant?

The Tree Species and Spacing's Figure contains four lists of trees, one list for each tree type category. Once an individual has looked at the Forest Plan Map and determined the tree type category for the location of the tree to be planted the tree list for that category is consulted. The individual may select from any of the tree species on the list for that specific tree type. Special written permission must be received from the Shade Tree and Beautification Commission if a tree species **not** included in the list for that area is desired. The tree species contained in these lists have been carefully selected. They have been separated into each category according to their mature size and form. Some trees, perhaps some of your favorites, do not appear in the lists because of one or several of the following reasons: they are prone to insects and disease problems, they drop twigs, large fruits, and other debris, they easily reseed and can become "weeds," they are not entirely hardy in Wellsville, they have weak wood and are subject to storm damage, or they do not grow well in local soils. You can be relatively confident that any of the trees selected from the tree lists will thrive if they are watered frequently after planting and not abused. Use the recommended spacings for each species when planting more than one tree. If you have any questions as to what tree species can be planted in the planting strip adjacent to your property or which species are most desirable, contact a member of the Shade Tree and Beautification Commission.

Wellsville Community Forest Plan Map

WELLSVILLE COMMUNITY PATTERN INVENTORY

Any effective planning must have at its foundation an accurate inventory of existing conditions. Therefore, to create an effective Community Forest Plan, it was necessary to record in a usuable form as much information about what conditions and patterns exist currently in Wellsville. Only information that was pertinent to a Forest Plan was considered.

The items considered in what we call the Community Pattern Inventory were as follows:

1. Land use data was catagorized into what land was open or agricultural, or used as residential, recreational, industrial, commercial, or institutional (church, state, or municipally owned).
2. Streets were classified into major and minor catagories depending on the amount of travel they received.
3. Overhead wires and their heights above ground were recorded.
4. Reservoirs, canals, and streams and existing tree masses were mapped.
5. Trees of special significance due to their type, size or form were located and labeled as Distinctive Trees.
6. Desirable and undesirable views of a general nature were identified.
7. Steep slopes which would require special attention were located and mapped.
8. Planting strips along the sides of roads which were less than four feet wide were located.
9. Areas receiving a great deal of active public use were also pinpointed.

After this information was gathered, it was then compiled into one map for easy accesibility and comparison. Each item was keyed, land uses being different colors, steep slopes being croshatched, and so on.

Once this information was compiled, it was double checked to make sure it was accurate.

The final composite Community Pattern Inventory Map portrays the visual and spatial structure of Wellsville. The strong tree-lined grid pattern of the city is evident. This pattern loses its rigidity in the east portion of the city, where open fields and bottomlands create a more free-form pattern. The map also shows where constraints are imposed upon the selection and location of street trees. For example, the existance of low overhead wires suggests that only small trees can be located underneath them to avoid conflicts between the wires and trees. Opportunities for street tree plantings are greatest along major streets without trees and in the center of Wellsville, which receives a great deal of use by citizens of all ages. These are just a few examples of how the Community Pattern Inventory Map can be used to identify existing opportunities and limitations to the selection and location of street and park trees in Wellsville.

Formal Large Trees

BOTANICAL NAME	COMMON NAME	SPACING (In Feet)
Acer platanoides	Norway Maple	35-45
Acer rubrum	Red Maple	30-40
Celtis occidentalis	Common Hackberry	30-40
Fraxinus americana	White Ash	35-45
Fraxinus excelsior	European Ash	30-40
Fraxinus pennsylvanica lanceolata	Green Ash	35-45
Ginkgo biloba	Maidenhair Tree (Male)	25-35
Gleditsia triacanthos c.v.	Honeylocust	35-45
Gymnocladus dioicus	Kentucky Coffee Tree	25-35
Platanus acerifolia	London Plane Tree	40-50
Tilia species	Linden species	30-40
Ulmus americana	American Elm	40-50
Ulmus parvifolia	Littleleaf Elm	30-40

Formal Medium Trees

BOTANICAL NAME	COMMON NAME	SPACING (In Feet)
Acer campestre	Hedge Maple	20-30
Koelreuteria paniculata	Goldenrain Tree	20-30
Morus alba	White Mulberry "fruitless var."	25-35
Sophora japonica	Japanese Pagoda Tree	30-40
Syringa amurensis japonica	Japanese Tree Lilac	20-30

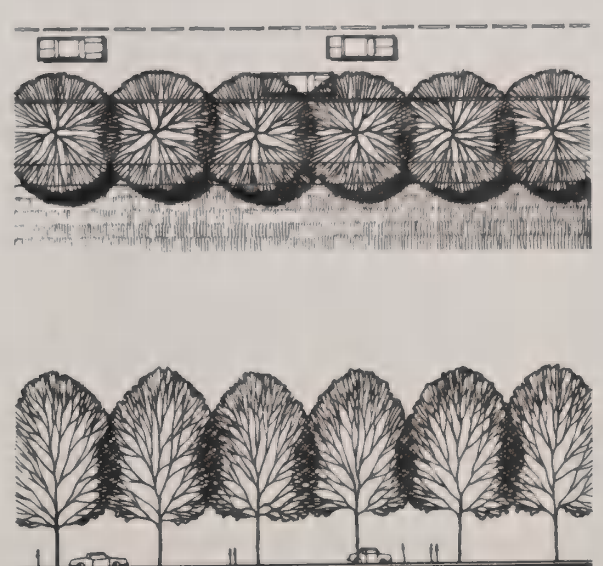
Formal Small Trees

BOTANICAL NAME	COMMON NAME	SPACING (In Feet)
Acer ginnala	Amur Maple	15-25
Cercis canadensis	Eastern Redbud	15-25
Crataegus lavallei	Carriere Hawthorn	20-30
Crataegus oxyacantha	English Hawthorn	20-30
Crataegus phaenopyrum	Washington Hawthorn	20-30
Malus species	Crabapple species	20-30
Prunus blireiana "Newport"	Newport Flowering Plum	15-25
Prunus cerasifera	Purple-Leaf Plum	15-25
Prunus serrulata	Japanese Flowering Cherry	15-25
Pyrus calleryana	Bradford Flowering Pear	15-25

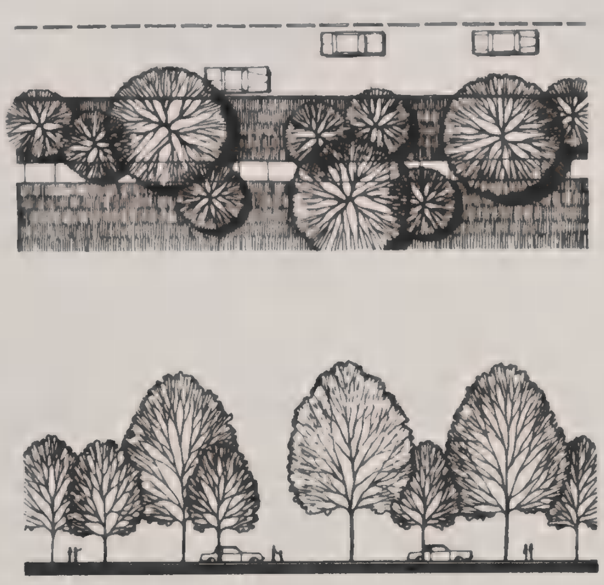
Informal Mixed Trees

BOTANICAL NAMES	COMMON NAME	SPACING (In Feet)
Betula occidentalis	River Birch	15-25
Crataegus rivularis	River Hawthorn	15-25
Elaeagnus angustifolia	Russian Olive	25-35
Populus species	Poplar species	varies
Salix species	Willow species	varies

Tree Species and Spacings For Each Tree Type Category



Plan view and elevation of large trees in a formal planting pattern.



Plan view and elevation of mixed tree sizes in an informal planting pattern.

WELLSVILLE COMMUNITY FOREST: MANAGEMENT

In order to adhear to the conscientious guidelines set forth in the Wellsville City Tree Ordinance and Forest Plan, the Shade Tree and Beautification Commission have utilized different procedures to develop their current management strategy.

Tree Inventory

The Commission investigated the 1980 tree inventory that had been conducted by and for the City of Wellsville. During the inventory, information such as the following was recorded for each tree:

1) date of inventory
2) location
   a) section of the city
   b) block number
   c) lot number
   d) address
3) species
4) size
5) condition
6) corrective procedure necessary

To increase the ability of this tree data to be used as a planning and management resource, a computer program was developed by a student of Landscape Architecture and Environmental Planning at Utah State University. The program uses the Wellsville tree data (with minor adjustments), and allows for its rapid storage, retrieval and display. Some of the more pertinent results are shown below.

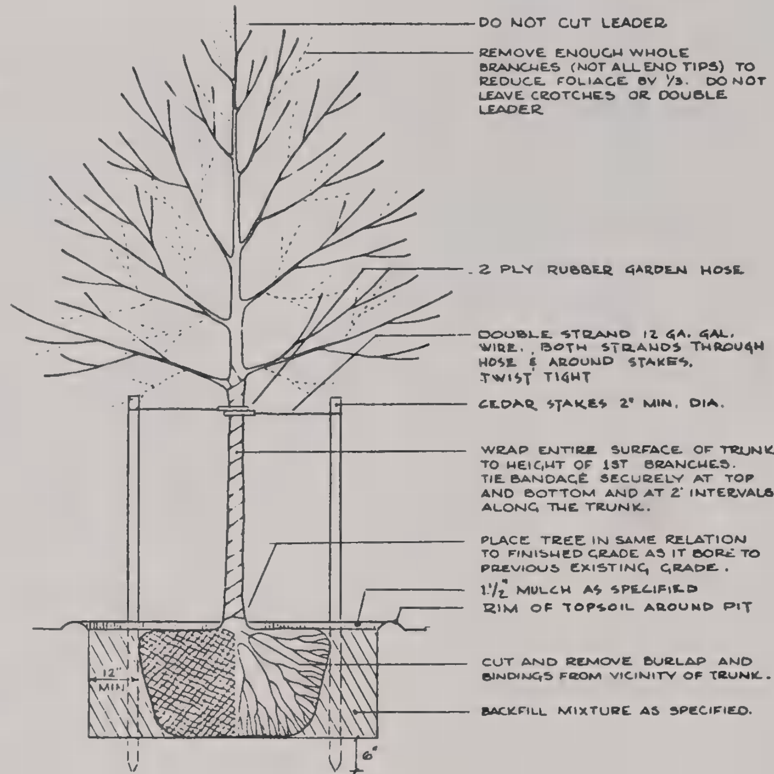
Management Options

As can be seen by this information, many trees are in need of attention, but most striking are the results of Number 4 (Stand Age by Height), which indicates that the majority of trees are mature in size and will be in the near future meeting their life expectency. Becase of this the Commission has decided that their number one priority is to reforest Wellsville. The first step in this direction will consist of an Arbor Day planting on May 1 of approximately thirty trees around the softball field and in the city square. The Commission plans to use a majority of their yearly budget to purchase and plant trees throughout the city in the years ahead. This will insure that new trees will exist to replace the large number of old ones that will eventually die.

The Commission has identified seven trees on the city square that need to be removed. Some of these are diseased and others are suffering from extreme overcrowding. The removal of these trees will improve the form, health, and beauty of the surrounding trees. It is expected that in the future a small portion of the yearly budget will be allocated to tree removal as the situation warrants.

While the Commission feels that the planting of new trees is most critical, they also recognize that there is an immediate need to allocate funds for tree maintenance. in the next few years available funds will be used to pay for the pruning of trees in the city square and throughout the community. Some of these trees have large broken limbs that are hazards to persons and property.

The Wellsville City Council and the Shade Tree Beautification Commission are beginning an ambitious plan to reforest and beautify the city. With your support this will become a reality.



Typical planting and staking detail for trees up to 3" caliper.

1. **Total Number of Trees** 807
2. **Total Estimated Tree Value** $1,866,431.00
3. **Trees by Species**

Tree Species	Total No.	% of Total
1. Green Ash	405	50
2. Black Locust	97	12
3. Lombardy Poplar	56	7
4. Norway Maple	50	6
5. Siberian Elm	42	5
6. Box Elder	41	5
7. Linden	18	2
8. Willows	17	2
9. Other	81	11

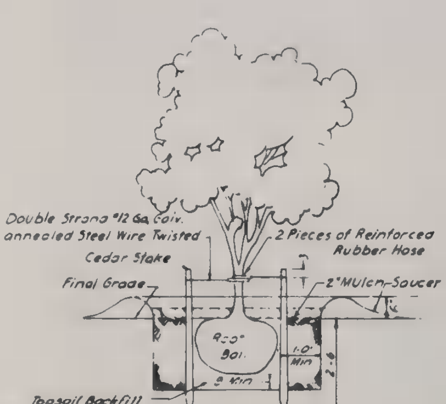
4. **Stand Age by Height**	**Total No.**
a. Trees under 10'	26
b. Trees 10'-50'	244
c. Trees over 50'	537

5. **Management Need**	**Total No.**
a. Pruning	162
b. Wound Repair	14
c. Insect and Disease Control	90
d. Removal	2

6. **Condition**	**Total No.**
a. Good	662
b. Fair	60
c. Poor	82
d. Dead or Dying	2

7. **Planting Needs**
   Wellsville has room for 2,250 trees in planting strips alone. This is based upon an average of 45 trees per block with about 11 trees on each side of the block and a 50 foot spacing.

TREE INVENTORY RESULTS



Typical planting and staking detail for low branching trees.

CITY COUNCIL ADOPTS TREE ORDINANCE

On Thursday, April 8, the Wellsville City Council adopted the Wellsville City Tree Ordinance. The ordinance was presented by the Beautification Committee and is one of several steps taken by the Committee to make Wellsville eligible for Tree City USA.

The Tree Ordinance provides for the establishment of a Shade Tree and Beautification Commission. Nine members of the former Beautification Committee are now members of the Commission, and David Bell was appointed by the Mayor to fill the remaining position. In addition, City Councilman Dick Wells is a non-voting member of the Commission and its liason with the City Council.

The Tree Ordinance charges the Commission with the responsibility of planning and managing the community forest of Wellsville in addition to organizing clean-ups and other beautification activities.

Another provision of the Tree Ordinance states that street tree and park plantings on city property must conform in species and location with the Wellsville City Community Forest Plan and the Arboricultural Specifications. The Ordinance also requires that in the case of new development, the developer must purchase and plant street trees in the city-owned planting strip as designated by the Community Forest Plan. The purpose of this is to promote the re-foresting of Wellsville, since the majority of trees on city property are old or dying.

Any person wishing to remove a tree on municipally-owned property must first obtain a Tree Removal Permit from the Commission. The intent of this section is to protect the street and park trees of Wellsville from the saws of overeager individuals in search of cheap firewood or "tree-haters" who would just as soon see a tree destroyed as planted.

Provisions for public tree care, pruning of trees creating safety problems, and dead or diseased tree removal on private property are included in the Tree Ordinance.

The Tree Ordinance places no restrictions upon the homeowner's right to do whatever they desire with trees on their own property unless they endanger the public. In addition, no regulations govern the way a homeowner may prune, fertilize, water, spray, or otherwise maintain trees on public property in front of their home. The Shade Tree and Beautification Commission encourages individuals to properly maintain the street trees in front of their homes and has a short document (Arboricultural Specifications) which describes the correct way to plant, maintain, and remove trees.

The Wellsville City Tree Ordinance represents a committment by concerned citizens to preserve and perpetuate the trees of Wellsville for generations to come. It is reprinted in its entirety in this newspaper.

TREE ORDINANCE

AN ORDINANCE REGULATING THE PLANTING, MAINTENANCE, AND REMOVAL OF TREES IN THE PUBLIC STREETS, PARKS, AND OTHER MUNICIPALLY-OWNED PROPERTY: ESTABLISHING A SHADE TREE AND BEAUTIFICATION COMMISSION AS THE AGENCY PRESCRIBING REGULATIONS RELATING TO THE PLANTING, MAINTENANCE AND REMOVAL OF TREES IN PUBLIC PLACES: PROVIDING FOR THE ISSUING OF PERMITS FOR THE REMOVAL OF TREES IN PUBLIC PLACES: PROVIDING FOR THE PRUNING AND REMOVAL OF TREES ON PRIVATE PROPERTY WHICH ENDANGER PUBLIC SAFETY: AND PRESCRIBING PENALITIES FOR VIOLATIONS OF ITS PROVISIONS.

BE IT ORDAINED BY THE COUNCIL OF THE MUNICIPALITY OF WELLSVILLE, COUNTY OF CACHE, STATE OF UTAH.

Section 1: **Definitions**

Street trees: "Street trees" are herein defined as trees, shrubs, bushes, and all other woody vegetation on public lands lying within the right-of-way of all streets, avenues, or ways within the city.

Park Trees: "Park trees" are herein defined as trees, shrubs, bushes and all other woody vegetation in public parks and all areas owned by the City, or to which the public has free access as a park.

Section 2: **Creation and Establishment of a Shade Tree and Beautification Commission**

There is hereby created and established a Shade Tree and Beautification Commission for the City of Wellsville, Utah, which shall consist of eleven (11) members, citizens and residents of this city. Ten (10) of said members shall be appointed by the Mayor with approval of the Council. The eleventh (11th) member shall be the City Council member responsible for activities of the Shade Tree and Beautification Commission (Commission) and shall be an ex-officio member. All members of the Commpssion shall serve without pay.

Section 3: **Term of Office**

The term of the ten (10) persons to be appointed by the Mayor shall be three (3) years except that the term of two (2) members appointed to the first Commission shall be for only one (1) year and the term of two (2) members appointed to the first Commission shall be for two (2) years. Appointments to office will be made on or before the first Monday in February of each year. In the event that a vacancy shall occur during the term of any member, his or her successor shall be appointed for the unexpired portion of that term.

Section 4: **Duties and responsibilities**

The duties and responsibilities of the Commission are as follows:

To study the problems and determine the needs of the City of Wellsville, Utah, in connection with its community forest.

To adopt and then periodically review and update a Wellsville City Community Forest Plan, which designates the type and kind of trees to be planted upon municipal streets and in parks.

To collect and allocate funds from public and private sources for the planning and management of the community forest and the beautification of Wellsville City.

To assist in the dissemination of news and information regarding the selection, planting, and maintenance of trees within the corporate limits, whether they be on public or private property, and to make such recommendations from time to time to the City Council as to desirable legislation concerning the community forest program and activities for the municipality.

To consider, investigate, make finding, report, and recommend upon any special matter or question within the scope of its work when requested by the City Council.

Section 5: **Operation**

The Commission shall choose its own officers, make its own rules and regulations, and keep a journal of its proceedings. A majority of the members shall be a quorum for the transcation of business.

Section 6: **Planting**

Street tree plantings must conform in species and location with the Wellsville City Community Forest Plan. No species other than those included in the Forest Plan may be planted as Street Trees or Park Trees without written permission of the Commission and trees may only be selected from the tree list that corresponds with the specific proposed tree location as designated in the Forest Plan.

In the case of new residential, industrial, or commercial development (of any size or type), the developer shall be responsible for new Street Tree planting. The developer must purchase and plant Street Trees in the public right-of-way no smaller than 3/4 inch caliper which conform in species and spacing to the Forest Plan and sections 6 through 8 of this ordinance. Persons planting trees shall abide by the Arboricultural Specifications adopted by the Commission.

Section 7: **Spacing**

The spacing of Street Trees shall be in accordance with the spacing ranges designated in the Forest Plan. Exceptions must be approved by the Commission.

Section 8: **Distance From Street Corners and Fireplugs**

No Street Tree shall be planted closer than 40 ft. to any street corner, measured from the point of intersection of the streetlines. No Street Tree shall be planted closer than 10 ft. to any fireplug.

Section 9: **Public Tree Care**

The City shall have the right to plant, prune, maintain, and remove trees, plants and shrubs within the lines of all streets, alleys, avenues, lanes, squares, and public grounds, as may be necessary to insure public safety or to preserve or enhance the symmetry and beauty of such public grounds. The Commission may remove or cause or order to be removed, any tree or part thereof which is in an unsafe condition or which by reason of nature is injurious to sewers, sidewalks, electric power lines, gas lines, water lines, or other public improvements, or is affected with any injurious insect, pest, or disease. This Section does not prohibit the planting of Street Trees by adjacent property owners provided that the selection and location of said trees is in accordance with Sections 6 through 8 of this ordinance.

Section 10: **Pruning, Corner Clearance**

Every owner of any tree overhanging any street or right-of-way within the City shall prune the branches so that such branches shall not severely obstruct the light from any street lamp or obstruct the view of any street intersection and so that there shall be a clear space of 8 ft. above the surface of the street or sidewalk. Said owners shall remove all dead, diseased, dangerous, broken or decayed limbs that constitute a menace to the safety of the public. The City shall have the right to enter upon private property to prune any tree or shrub on said private property when it interferes with the proper spread of light along the street from a street light, or interferes with the visibility of any traffic control device or sign.

Section 11: **Dead or Diseased Tree Removal on Private Property**

The City shall have the right to cause the removal of any dead or diseased trees on private property within the City, when such trees constitute a hazard to life and property, or harbor insects or disease that constitute a potential threat to other trees within the City. The Commission will notify in writing the owners of such trees. Removal shall be done by said owners at their own expense within sixty days after the date of service of notice. In the event of failure of owners to comply with such provisions, the City shall have the authority to enter upon said property to remove such trees and charge the cost of removal on the owner's property tax notice.

Section 12: **Tree Removal on Public Property**

No person shall remove or otherwise seriously disturb any tree on any municipal-owned property without first filing an application and procuring a permit from the Commission. The person receiving the permit shall abide by the Arboricultural Specifications adopted by the Commission.

Application for permits must be made with the Commission not less than forty-eighty (48) hous in advance of the time work is to be done.

Standards of Issuance. The Commission shall issue the permit provided for herein if, in its judgement, the proposed work is desirable and the proposed method and workmanship thereof are of a satisfactory nature. Any permit granted shall contain a definite date of expiration and the work shall be completed in the time allowed in the permit and in the manner as therein described. Any permit shall be void if its terms are violated.

Notice of completion shall be given within five (5) days to the Commission for their inspection.

Section 13: **Interference with Shade Tree and Beautification Commission**

It shall be unlawful for any person to prevent, delay, or interfere with Wellsville City personnel, the Commission or any of its agents, while engaging in and about the planting, cultivating, mulching, pruning, spraying, or removing of any Street Trees, Park Trees, or trees on private grounds as authorized in this ordinance.

Section 14: **Arborists License and Bond**

It shall be unlawful for any person or firm to engage in the business or occupation of pruning, treating, or removing street or park trees within the City without first applying for and procuring a license. The license fee shall be $15.00 annually in advance; provided, however, that no license shall be required of any public service company or City employee doing such work in the pursuit of their public service endeavors. Before any license shall be issued, each applicant shall first file evidence of possession of liability insurance in the minimum amounts of $25,000.00 for bodily injury and $250,000.00 property damage, indemnifying the City or any person injured or damaged resulting from the pursuit of such endeavors as herein described.

Section 15: **Review by City Council**

The City Council shall have the right to review the conduct, acts, and decisions of the Shade Tree and Beautification Commission. Any person may appeal any ruling or order of the Commission to the City Council who may hear the matter and make a final decision.

Section 16: **Penalty**

Any person violating any provision of this ordinance shall be, upon conviction or a plea of guilty, subject to a fine not to exceed $299.00.

Section 17: **Effective Data**

This ordinance is hereby declared to be of immediate necessity for the preservation of public peace, health, and safety, and shall be in full force and effective from and after its passage and publication as provided by law.

COUNCIL MEMBERS

Mayor: Kent Brenchley

Council Members: William Ray Bankhead, Keith E. Call, Dean Kerr, Andrew Stokes, Richard Wells

COMMISSION MEMBERS

Chairman: Dean Riggs

Commission Members: Ruth Bankhead, David Bell, Betty Haflam, Dean Haflam, Carol Kerr, John Kerr, Jr., Glenda Riggs, Don Smart, John Spence, Richard Wells

E.F.S.

Utah State University Environmental Field Services

Department of Landscape Architecture and Environmental Planning

EFS Project Coordinator: Greg McPherson

EFS Coordinator: Assistant Professor Lee Nellis

EFS Students: Nate Brown, Bruce Nickerson

Department Head: Richard E. Toth

Utah State University's Environmental Field Service program matches community development needs in Utah and adjacent states with the need of students in its Department of Landscape Architecture and Environmental Planning for a practical education. EFS offers communities with limited resources the energy and enthusiasm of students and the experienced guidance of faculty to accomplish planning or design projects for which funding adequate to retain private sector consultants is not available. Information on the EFS program may be obtained by writing: Environmental Field Service Coordinator, Department of Landscape Architecture and Environmental Planning, UMC 40, Utah State University, Logan, UT 84322 or by calling (801)750-3471. Inquiries from communities with project needs are invited.

Acknowledgements

We would like to thank a number of people and organizations who made this publication possible.

The Wellsville Youth Council provided invaluable assistance in distribution of this tabloid. The members of the Beautification Committee gave a great deal of their time to all phases of the study and distribution of the tabloid. Finally, thanks goes to the City Council for supporting this project.

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APPENDIX F

Interior Western United States
Urban Forestry Survey

December 9, 1988

INTERIOR WESTERN STATES URBAN FORESTRY SURVEY
Questionnaire Response Summary - DO Have copy of Manual

Name/Title	City/Chara.	Pop.	Indicators of Effective Tree Care	Rate Comm	Rate Manual	Number Request	Reviewer's Comment

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T R C C T A P T M P P T G F W A M T T   P T E
R E I I R R A R A U A R U U O R E   O   R E F
E S T T E B T E S B R E I N R B D C T   O C F
E     Y E O T E T L T E D D K O I I     G H E
  S E     R     E I     E     R A T R     N C
B U D F D I I I R C D O L S P     Y A   D I T
O R U O E S N N     E R I O L D I   T   E C I
A V C R P T V V P R V D N U A A N U I   V A V
R E A E T S E E L E E I E R N Y V S N   E L E
D Y T S     N N A V L N S S     O A G   L
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R - Reference meterial
P - Photographs
G - Graphics

NATIONAL LEADERS

Name/Title	City/Chara.	Pop.	Indicators of Effective Tree Care	Rate Comm	Rate Manual	Number Request	Reviewer's Comment
1 Neil Letson I & E Forester	Montgomery AL ******	******	* * * * * * * * * * * * * * * * * *	*	2 1 2	25	
2 Greg McPherson Assist. Prof.	Tucson [redacted] Desert	300000	2 2 2 0 1 1 0 0 0 0 0 0 0 0 0 2 0 0	*	2 3 2	20	
3 Jim Nighswonger Ur Fo Prog Leader	Manhattan KS Valley	33000	0 2 2 1 1 1 1 2 * 2 1 1 1 * 1 1 1 1	2	2 2 2	12	R,P, Wastewood utiliz. & disposal
4 William Ripley Coop. For. Mg. Sp	****** ******	*****	* * * * * * * * * * * * * * * * * *	*	1 1 *	1	Returned ques. only
5 John Ronald Coop. For. Mg.	Petaluma, CA Interior Coastal	*****	0 0 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0	3	2 2 *	6	Cailf. has own manual

National Leaders — RATING SUMMARY

	Excellent	Good	Average	Poor	Total
Community Tree Care	6	7	7	5	25
Current Manual (Have Manual)					
Program Development	1	4	0	0	5
Technical Tree Care	2	2	1	0	5
Effectiveness	0	3	0	0	3

National Leaders — SURVEY RESPONSE

Number Mailed	75
Number Responding	31 (44%)
Do Have Manual	5
Do Not Have Manual	26
Number Manuals Requested	187

WESTERN STATES

CALIFORNIA

Name/Title	City/Chara.	Pop.	Indicators of Effective Tree Care	Rate Comm	Rate Manual	Number Request	Reviewer's Comment
1 Eric Oldar Regional Forester	Riverside Sagebrush	500000	1 1 0 1 1 1 1 2 0 0 1 1 1 1 1 2 0 2	3	2 2 1	25	R, Rec ommendations
2 James P. Ryugo Arbor. Inspector	Oakland Coastal/Marine	351000	0 0 2 1 1 1 1 1 1 0 1 1 1 * 1 1 0 1	2	* * *	*	

	TEXAS						
	KANSAS						
3	Paul G. Jantzen Tree Brd. Chrm.	Hillsboro Praire	2800	1 0 1 0 1 0 0 1 0 0 1 1 1 0 1 0 1 0 2	* * *	3	
	COLORADO						
4	Philip J. Hoefer Staff Forester	Ft. COLLINS Praire	80000	1 1 0 1 1 1 1 1 0 0 1 1 1 1 1 1 1 1 2	3 2 2	140	R,P,G-Annual work plan, use comments
	SOUTH DAKOTA						
5	Tom A. Draper Dist. Forester	Yankton Valley	12000	2 0 2 2 2 2 0 2 0 0 2 2 2 0 2 2 2 2 2	2 2 2	10	
6	David Erickson Div. Staff Spec.	Pierre ***	****	* * * * * * * * * * * * * * * * * * *	1 1 1	10	R, fertilizing
	IDAHO						
7	Jim Colla Private Forestry	Emmett Valley	3000	2 0 0 0 0 0 0 2 0 0 2 1 0 0 0 0 2 0 4	1 3 2	12	Case study does not apply
8	Steve Churchillo Supt. Urb. Forest.	Boise High desert	180000	1 0 2 1 1 1 0 1 1 0 2 1 1 1 1 1 1 1 2	3 3 3	15	R, Constuction damage cit. lobby $42,000
9	Wayne S. Johnson Asst. Prof. Hort.	Reno Valley	150000	2 0 2 1 1 1 0 0 2 0 2 1 0 1 1 2 1 2 2	2 1 2	30	R, Example
	NORTH DAKOTA						
10	Craig Foss Comm. For. Spec.	Carrington Praire	2500	0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 * 1 0 3	1 1 2	8	R, P, G, ND handbook
	MONTANA						
11	Bob Andreozzi RC & D Forester	Anacanda Valley	6000	0 2 0 0 0 0 0 0 0 0 2 0 0 0 0 2 2 0 4	1 2 1	6	P, How to raise dollars
12	Randy Lilje Dir. of Parks	Helena Valley	25000	0 0 1 1 1 1 2 0 0 0 1 1 1 1 1 1 1 1 3	2 2 2	2	
13	Mark Lennon Supt. For. Asst.	Missoula Valley	40000	2 0 2 2 1 2 0 1 0 0 * 1 1 0 1 2 2 2 2	1 1 2	50	R, Intersting check list
14	John Walkowiak Forester	Lewiston Mtn. Valley	7000	2 0 2 0 0 0 2 2 2 2 2 2 2 2 2 2 2 2 2	1 1 2	20	R, P, G Enclosed
15	Ron Wakimoto Assoc. Prof.	Missoula Valley	70000	2 0 2 2 1 1 0 1 0 0 0 0 2 * 0 1 1 1 4	2 2 1	8	R, Reference material enclosed
	NEBRASKA						
16	David Mooter Comm. Forester	Omaha River City	350000	1 0 1 1 1 1 0 1 0 0 0 1 1 0 1 1 1 1 2	3 3 3	10	Review letter & sample ordinance
17	Tamra Lehuta Urban Forester	Missoula Valley	33000	2 0 1 1 1 1 1 1 0 0 0 1 0 0 1 1 1 1 3	2 2 2	3	How on limited funds

	WYOMING						
18	Kevin M. Murphy Parks Manager	Evanston Sagebrush	12200	2 0 2 1 0 1 0 0 0 0 0 0 1 0 1 1 0 0 4	2 3 2	3	
19	Neil O. Schiche Chr. Tree Brd.	Buffalo Mtn. Base	3500	2 0 0 0 0 0 0 0 0 0 * 2 * 2 * 2 2 2 3	1 1 1	2	
20	Alan Kieper Parks Supt.	Casper Praire	45000	2 0 0 2 0 0 0 0 0 0 1 2 0 0 0 0 0 4	3 2 2	2	R, Suggestions
21	Dan Perko Staff Forester	Cheyenne Praire	50000	1 0 0 1 1 1 0 0 0 0 0 1 2 0 2 2 0 2 2	1 2 2	40	R, suggestions quote
22	Bonnie Cook Chairman	Worland Valley	6300	2 0 2 0 1 0 0 2 0 0 0 2 0 0 2 1 1 2 3	2 2 2	3	Success example
23	Lisa Olson City Forester	Cheyene Praire	52000	2 0 2 2 2 2 0 0 2 2 2 2 2 0 2 2 2 2 1	1 1 1	1	R,P, Recommendations
	UTAH						
24	Craig Pettigrew Bear Rv. Ar. For.	Logan Valley	25000	1 1 0 1 0 1 0 1 0 0 1 1 1 0 0 1 1 1 3	2 2 2	4	P, Yes
25	George Shaw City Planner	Sandy City	80000	1 0 2 2 2 * 2 0 1 1 1 0 0 0 2 1 1 0 3	1 1 1	4	
26	Steve Schwab City Forester	Salt Lake City Valley	168000	2 0 2 2 2 2 0 2 0 0 2 2 2 2 2 2 0 0 3	2 2 2	5	R, G, enclosed
27	Bill Meyers City Forester	Logan Valley	35000	2 2 0 2 2 1 0 1 1 0 1 2 0 0 0 1 1 0 3	1 2 1	3	Too general in areas
28	Larry Sagers Horticulturist	Salt Lake City Urban Area	650000	1 0 1 1 1 1 0 1 1 0 1 1 1 0 1 1 1 0 4	2 3 3	15	
29	David C. Schen Prog. Spc/Fst. Mng.	Layton Desert	***	0 0 0 0 0 0 0 0 0 0 0 * 0 0 0 0 0 0 4	1 2 2	*	Responsible for Utah
30	Alex Morris Grounds Supv.	South Jordan Rural/Urban	3000	2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3	2 2 1	12	P, Climbing spikes? How to work large trees? Manual index.
31	Jay M. Lowder Urban Forester	Ogden Valley	64607	2 0 0 2 1 1 0 0 0 0 2 1 0 0 0 1 0 1 4	3 2 2	2	R, Case study suggesting quote on Murray & SLC
	KANSAS						
	OREGON						
32	Steve Lindsey Assoc. Planner	Corvallis Valley	45000	0 0 0 1 1 1 * 2 0 0 1 2 2 0 2 0 0 0 4	2 3 2	1	G, trees before and after
33	Stephen Goetz Grounds Mang.	Portland Valley	475000	1 1 1 1 1 1 1 0 0 0 1 1 1 1 0 1 0 1 3	2 3 3	20	R,Fund raising tree politics
	NEVADA						
34	Wayne Johnson Prof. Hort.	Reno Valley	150000	2 0 2 1 1 1 0 0 2 0 2 1 0 1 1 2 1 2 2	2 1 2	30	R-Example
35	Richard L. Post Area Hort. Spec.	Carson City High Desert	300000	2 0 2 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 2	1 1 1	4	Subtropic Mohave desert plants, etc.
36	J. Balliette Agent in Charge	Battle Mtn. Desert	4000	0 0 2 0 0 0 2 2 0 0 2 0 2 2 0 0 2 0 4	1 1 1	***	VCR tape
37	Lisa Olson City Forester	Cheyenne Praire	52000	2 0 2 2 2 2 0 0 2 2 2 2 2 0 2 2 2 2 1	1 1 1	1	R, P, reccommendations
	LATE RESPONSES						

Western States	RATING SUMMARY	Excellent	Good	Average	Poor	Total
	Community Tree Care	9	29	45	29	112
	Current Manual (Have Manual)					
	Program Development	15	15	5	0	35
	Technical Tree Care	12	16	7	0	35
	Effectiveness	12	19	4	0	35

Western States	SURVEY RESPONSE	
	Number Mailed	265
	Number Responding	115 (43%)
	Do Have Manual	37
	Do Not Have Manual	73
	Number Manuals Requested	823

LEGEND

Indicators of Effective Tree Care
2 Yes, within the last 6 years
1 Yes
0 No
* No response

Rate Community/ Rate Manual
1 Excellent
2 Good
3 Average
4 Good

December 9, 1988

INTERIOR WESTERN STATES URBAN FORESTRY SURVEY
Questionnaire Response Summary - DO NOT Have Copy of Manual

R - Reference material
P - Photographs
G - Graphics

	Name/Title	City/Chara.	Pop.	Indicators of Effective Tree Care: TREE BOARD	RES SURVEY	CIT EDUCAT	CITY FORES	TREE DEPT	ARBORISTS	PATT INVEN	TREE INVEN	MASTER PLA	PUBLIC REV	PART OEVEL	TREE ORDIN	GUIDELINES	FUND SOURS	WORK PLAN	ARBOR DAY	MEDIA INVO	T CITY USA	Rate Comm: TOT RATING	Rate Manual: PROG DEVEL	TECHNICAL	EFFECTIVE	Number Request	Reviewer's Comment
	NATIONAL LEADERS																										
1	Bailey Hudson Park Superint.	Santa Maria CA Valley	52300	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	20	R, Model program, conducting research
2	Chuck Weber City Arborist	Huntsville AL E. Hardwoods	175000	1	0	2	2	0	0	0	0	0	0	1	1	1	1	0	1	1	1	4	1	1	1	1	Tree City USA is a failure restarting program
3	Billy Page USFS	GA	*****	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	1	1	
4	Steve Spezia Dist. Forest	Glencoe MO Upland Hard	*****	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	20	
5	Susan B. Kleto Consul. owner	Madison FL	*****	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	
6	John Morell City Forester	Park Ridge IL Praire	37620	1	0	1	1	1	1	0	1	0	0	1	1	1	0	1	1	1	1	1	*	*	*	1	R, Wound repair, cavity treat., G - auger specifications
7	Jennifer Schroeder Ur. Forest Spec.	Cincinnati OH River/Glacier	387425	2	0	2	2	2	1	0	2	2	0	0	2	2	2	2	2	2	2	2	1	2	2	1	Project site evalutation, selection & planting, maintenance
8	Fred Maier Director	Itasca IL Praire	8500	2	0	0	1	2	2	0	0	0	0	0	2	0	0	1	2	0	2	2	*	*	*	0	
9	Patrick R. OBrien Forestry Inspect.	Toledo OH Cont. Hardwood	325000	1	0	1	1	1	1	0	2	2	0	0	1	1	1	1	2	1	1	3	*	*	*	2	Perf. Standards. Improv. P, contract perf.
10	James Urban Landscape Arch.	Annapolis MD Coastal Plains	30000	0	0	2	2	0	0	0	0	0	0	1	1	0	1	*	0	2	1	3	*	*	*	1	R, Soils!! Contracting! Staking, wrapping??
11	Jim Adkins Co. Arborist/Dir.	Jefferson Co. KY River Valley	800000	0	0	0	2	2	2	0	0	0	0	1	0	2	0	0	0	0	0	3	*	*	*	3	Just getting started, good comments
12	Donald C. Willeke Dir. AFA/Chm.	Minn MN Hardwood Forest	360000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	*	*	many	Const. damage (don't kill trees) planting in center city root zones
13	David Shaw Supt.	Monmouth Co. Suburban	550000	1	*	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0	0	1	*	*	*	1	
14	Tom Gargrave District Forester	Oswego IL Praire	4000	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	4	2	2	1	10	Root & root-surface area growth, good comments
15	Kirk Brown President	Mpls.& St. Paul MN River Flat	2000000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Const. damage & prevent Roots & importance
16	James G. Hermann Forestry Asst.	Mpls. MN City	320000	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	2	2	2	2	1	R, networking professionals tech. transfer
17	Hal Robson Park Dir.	Lake Forest IL Praire/Forest	16200	0	0	0	1	1	1	0	1	0	0	1	1	0	1	1	1	0	1	2	1	1	*	1	Preservation of tree sites
18	Ralph Sievert City Forester	Cleveland OH	520000	0	0	0	1	1	1	0	1	2	0	1	1	1	0	1	1	1	1	3	*	*	*	6	R, P, R-"seal" not "heal"
19	Steve Sandfort Urb. For. Mang.	Cincinnati Valley	385000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	2	1	R, safety, utilities, contracting
20	Thomas M. Morgan City Forester	Cleveland Urban Forest	56000	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	1	1	2	2	2	2	

21	Deborah Mills Dir. Res. Plan.	Charlottesville VA Temp. For./Field	100000	0 0 0 0 0 1 2 0 0 0 2 0 1 0 0 2 1 0 3	* * *	3	P
22	Deborah L Olienyk Urban Forester	Mercer Island WA	*****	* * * * * * * * * * * * * * * * * * 4	2 3 *	1	R
23	John Rosenow Executive Dir.	Lincoln NE Arbor Day Fond.	*****	* * * * * * * * * * * * * * * * * * *	* * *	*	
24	Ann Miller Dist. Urban Forest.	Findlay Swamp	35000	1 0 2 1 0 0 0 1 1 0 0 1 1 1 1 1 0 1 4	* * *	40	R, Ohio urban forestry info. encl.
25	Ron Jackson Urban Forester	Mobile Coastal Plain	****	1 0 1 2 1 1 2 2 * * 2 0 1 2 2 1 1 1 3	4 4 3	4	
26	Cheryl Kollin Prog. Manager	San Francisco Coastal	****	2 0 1 2 2 1 0 2 2 0 1 2 0 1 * 1 1 1 4	* * *	1	

WESTERN STATES

COLORADO

1	Judith O Connor City Forester	Thornton High Plains Desert	59000	0 2 2 2 2 2 0 2 0 0 2 2 2 2 2 2 2 2 2	1 1 1	2	R, Program only two years old
2	Roxelen Johnson Parks & Rec.	Edgewater Praire	4800	2 0 2 0 0 0 0 2 0 0 0 1 0 0 2 2 2 2 3	* * *	8	
3	Darrel Pearson Hort. Aide	Englewood Valley	35000	0 0 2 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 3	1 2 1	4	R, Quote to use
4	Paul Ryan City Forester	Lakewood Suburb	130000	0 2 1 1 1 1 1 0 0 0 1 1 1 1 1 1 0 1 2	1 1 1	3	Budget cuts Forestry first
5	Tim Buchanan City Forester	Ft. Collins Praire	90000	1 0 1 1 1 1 * 1 1 0 1 1 1 1 1 1 1 1 1	1 1 1	2	Model city
6	Blaine Peterson Forestry Supt.	Sterling Praire	12000	1 0 1 1 1 1 0 0 0 0 0 1 1 1 0 1 1 0 4	* * *	3	Under funded Under staffed
7	Rick Bowser City Forester	Aurora Praire	225000	0 1 2 1 1 1 0 2 0 0 0 1 1 1 1 2 2 1 2	* * *	4	R, Model city
8	Matthew Donberger Forester/Hort.	Highland Ranch Praire	10000	0 2 2 2 2 2 2 2 0 0 1 0 1 0 2 2 2 2 1	2 2 2	1	

SOUTH DAKOTA

9	Randy Ahrendt Forestry Supt.	Watertown Praire	17000	1 0 1 1 1 1 0 1 0 0 1 1 1 1 1 1 1 1 1	2 2 2	1	Educate public
10	David S. Ostrander City Forester	Aberdeen Praire	30000	1 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1	* * *	10	
11	Charles Hemmer Urban Forester	Sioux Falls Praire	85000	1 0 1 1 1 1 1 1 2 0 0 1 1 0 2 1 1 1 3	2 2 2	2	Door hangers enclosed
12	Norman W. Baer Asst. Prof.	Brookings Praire	15000	0 0 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 1 3	* * *	*	
13	Steven L. Texley Park & Rec. Dir.	Mitchell Praire	15000	1 0 1 1 1 1 0 0 0 0 1 1 1 0 1 1 1 1 4	1 1 1	4	
14	Gary Garner Urban Forester	Rapid City Foothills	54000	1 0 1 1 1 1 0 0 0 * 1 1 1 0 1 1 1 1 3	2 2 2	2	

IDAHO

15	Peter Volb Asst. Ext. Forest.	Moscow Valley	*****	0 1 1 0 0 1 0 0 0 0 1 0 0 0 0 1 1 0 4	* * 2	4	A good job is best promoter
16	Don White Area Forester	Coeur d'Alene Valley	25000	1 0 1 0 2 2 1 1 0 * 1 2 2 2 2 1 1 2 2	* * *	*	

NORTH DAKOTA

17 Jeff Heintz City Forester	Jamestown Valley	16000	1 0 1 1 1 1 0 2 0 0 0 1 2 1 0 1 1 1 3	* * *	2	R, Forestry Ordinance
18 Paul K. Weiser	Hazen Praire	3000	2 0 2 2 0 2 0 2 2 0 2 2 2 2 2 2 2 2 2	1 1 1	2	
19 Terry Schmidt City Forester	Mandan Praire	15300	1 0 2 1 0 0 1 1 0 0 1 1 0 1 0 1 0 1 4	* * *	0	
20 Dale Gaasland City Forester	Williston Praire	15000	2 2 1 2 1 1 1 1 0 0 0 1 1 0 0 2 2 2 3	3 3 3	1	R, To long for lay person
21 John Wesolowski City Forester	Fargo Praire	66042	1 0 1 1 1 1 1 1 0 0 1 1 0 1 1 1 1 1 2	* * *	5	
22 Chris Kuntz Hort./Forester	Minot Valley	35000	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 3	* * *	5	
23 David Crabtree County Hort.	Missoula Valley	*******	0 0 1 1 0 1 * * 0 0 0 1 0 0 1 2 2 2 4	1 2 1	2	
24 Chris Carlson City Forester	Bottineau Praire	3000	2 0 2 2 0 0 0 2 1 0 2 2 1 0 0 2 2 0 4	3 3 3	5	P, R, Source for Economical software
MONTANA						
25 E.G. Blackwell Park Supt.	Billing Valley	75000	1 0 1 1 1 1 0 1 0 0 0 1 1 0 1 1 1 1 3	2 2 2	3	Lack of funding No city forester R-Quote about manual use
26 David Crabtree County Hort.	Missoula Valley	*****	0 0 1 1 0 1 * * 0 0 0 1 0 0 1 2 2 2 4	1 2 1	2	
27 Tamra Lehuta Urban Forster	Missoula Valley	33000	2 0 1 1 1 1 1 1 0 0 0 1 0 0 1 1 1 1 3	2 2 2	3	How on limited funds?
NEBRASKA						
28 Nolan Rundquist City Arborist	Fremont Valley	24000	1 0 2 1 1 1 0 1 0 0 0 1 1 0 1 1 1 1 2	* * *	5	Planting 150% of removals, flyer attached
29 Gerald Vap Chairman	McCook Praire	8500	2 * 2 0 2 0 2 2 0 0 0 0 2 2 2 2 2 2 3	2 2 2	0	
30 Jim McDonald Street Supt.	David City Praire	2600	1 0 0 1 2 1 1 2 1 0 1 2 2 2 2 1 1 1 3	2 2 3	2	
31 Gary Liesenfeld Dir. Park & Rec.	Fairbury Praire	4800	2 * 2 2 2 2 2 2 2 2 0 2 2 2 2 2 2 2 3	* * *	2	Convience city council
32 Wil S. Higuchi Chairman	Sidney High Plains	6000	1 0 1 1 1 0 1 1 1 0 1 1 1 * 1 1 1 1 2	2 * *	6	
33 Donald J. Smith Director	Lincoln Praire	200000	1 0 1 1 1 1 0 1 1 0 1 1 1 0 1 1 1 1 1	2 1 2	2	
34 Edward Flake Chairman	NE City Valley	7250	2 0 * 0 2 1 1 1 0 0 1 1 0 1 1 1 1 1 2	* * *	2	
WYOMING						
35 Donald R. Drolet Chairman	Laramie Praire	25000	2 0 2 0 2 2 0 0 2 0 0 2 2 0 2 2 2 2 3	1 1 1	1	Getting started
36 Neva Rogers President	Torrington Valley	5500	2 * 1 1 1 0 0 1 0 0 0 1 1 1 1 1 1 1 3	1 1 2	4	Funding
OKLAHOMA						
37 Mark Goeller Dist. Forester	Vinita Praire	6800	0 0 1 0 0 0 0 2 0 0 2 0 0 0 0 0 2 0 4	1 1 1	3	No interst No funding
38 Steve Couch District Forester	Broken Bow Valley	10000	0 0 0 2 2 0 0 0 0 0 0 0 0 0 0 2 0 0 3	3 3 2	1	
39 C. Parkin Forester	Bartlesville Praire	35000	2 1 0 2 2 2 0 1 1 1 1 1 1 0 0 1 0 2 3	* * *	10	Arboretum
40 Stephen Mattax District Forester	Sallisaw Praire	*****	0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 4	2 3 1	5	No recognition
41 K.L. Atkinson	Edmond	40000	0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 2 0 3	1 1 1	1	Know it, Grow it"

	Assist. Dir.	Hardwood/Prairie						Dr. C. Whitcomb
42	Bob Harrel Service Forester	Woodwared Praire	14000	2 0 2 2 0 0 2 2 2 0 1 0 0 0 0 1 0 1 3	* * *		2	No planning trees for color
43	Robert P. Doye Staff Forester	Yukon ******	*****	* * * * * * * * * * * * * * * * * * *	1 1 1		10	
44	Dave Eastman Urban Forester	Nichols Hills Praire	4171	1 0 0 0 0 0 1 1 1 0 0 1 1 1 1 1 0 1 4	3 3 3		1	No forestry dept.
45	Sheri Medow Smith Service Forester	Duncan Praire	20000	0 0 0 1 1 0 0 0 0 0 1 0 0 0 1 0 0 0 3	* * *		2	
46	Grant S. Ehlen Urban Forest Mag.	Tulsa Other	750000	2 0 2 2 2 0 0 0 0 0 2 0 0 0 0 2 2 0 4	2 2 *		2	
	UTAH							
47	Lloyd Siegendorf Chm. Urban For.	S.L.C. Valley	160000	2 0 0 2 2 2 * 2 0 0 * * 2 2 * 2 * * 3	* * *		1	Politics" of program & ordiance
	WASHINGTON							
48	J. Alan Wagar Research Prof.	Seattle Maritime Forest	350000	0 0 1 1 1 * 0 * 0 * * * * * * * * * 3	2 3 2		2	Micro computers for inventory
	CALIFORNIA							
49	Pamela S. Bone Urban Hort. Adv.	Sacramento Valley	900000	2 * 2 2 2 2 * * 0 0 2 2 2 2 * 2 2 2 1	* * *		4	R, Model city P, Request
50	G.K. Bradney Park Supv.	Oxnard Seaside Community	130000	0 0 2 1 1 2 0 2 2 0 2 1 2 0 1 2 0 2 3	3 * 2		1	
51	Richard E. Dresser Resource Mgr.	Forturnia Forest mixture	3500	0 0 0 0 0 2 0 0 0 0 1 0 0 1 0 1 1 0 3	* * *		7	
52	Jim P. Carpenter	Oroville Foothill	10370	1 0 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 4	* * *	*		Lacking funding
53	Eric Oldar Reg. Ser. Forester	Riverside Sage. Locale	500000	1 1 0 1 1 1 1 2 0 0 1 1 1 1 1 2 0 2 3	2 2 1		25	R, recommendations
54	Robert Reid Urban Forester	Monterey Pine and Oak Forest	30000	0 0 0 1 1 1 0 0 0 0 1 1 0 0 1 1 1 1 3	2 2 2		1	Lacks prof. know.
55	Richard W. Harris Prof. Emeritus	Davis Valley	40000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 2	* * *		1	P, G, Arboriculture book by Harris
56	Jack Brazeal City Arborist	San Luis Obispo Coastal Valley	***	1 2 0 1 1 1 2 2 0 0 1 1 1 0 1 1 1 1 2	* * *		3	
	OREGON							
57	Earl E. Nichols President	Bend Regional Hub	90000	0 0 0 2 1 1 0 1 0 1 1 1 1 1 1 1 1 0 2	* * *	*		
58	Jeffrey A. Hale City Arborist	Eugene Valley	106000	2 0 0 1 0 1 0 1 0 0 1 1 1 0 0 1 0 1 3	* * *		10	Lacks funding
59	Woodrow Dukes	Salem	990000	1 0 0 1 1 1 0 0 2 0 0 1 1 2 0 2 0 1 3	* * *		3	R-Planting article
60	Mike Oxman Arborist	Grants Pass Valley	16000	2 0 2 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 4	1 1 1		24	P, side walks go around trees
	TEXAS							
61	Mark A. Peterson Staff Forester	San Antonio Savannah	1400000	0 0 1 2 0 1 * 0 0 0 0 0 0 0 0 0 0 0 4	* * *		1	Texas FS handbook
62	Jud Piner City Forester	Ft. Worth Praire/Timbers	430000	0 0 2 1 1 1 0 1 0 0 1 1 1 1 0 1 1 1 2	1 1 1		2	R-Ordiance
63	John P. Giedraitis City Forester	Austin Other	500000	2 * 2 2 1 2 0 2 0 0 * 2 0 1 0 2 2 2 3	* * *		25	R, Oak wilt info booklet
64	David M. Vaughn	San Antonio	1000000	0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4	3 4 3		0	

65	Dist. Mgr. Jeff Hanawalt Urban Forester	Other Houston Pine/Hardwood	2000000	2 0 1 1 1 1 0 0 * * 0 0 0 2 * 1 1 2 3	3 3 3	5	R, G, Planting Private firm success ex/dev & awards
	ALASKA						
66	William R. Robb Hort.-Park Dept.	Anchorage Valley	200000	0 0 0 2 2 0 0 0 0 0 1 2 0 0 0 1 1 0 2	1 1 1	2	
67	Matt Tyrala President	Anchorage Lowland	175000	0 0 0 0 0 0 0 0 0 0 2 2 0 0 0 1 0 0 4	* * *	10	
68	John J. Mahorcich Land Management	Soldotna Forest	43612	0 0 2 0 0 0 2 0 2 2 1 0 0 0 0 1 2 0 *	* * *	5	
69	Joe Wehrman Chief Res. Mang.	Anchorage Maritime Bowl	200000	0 0 2 1 0 1 0 0 0 0 0 0 0 U 0 1 1 0 3	2 3 2	13	
	KANSAS						
70	Tim Martz Supt. Land/For.	Wichita Praire	280000	1 0 1 1 1 1 0 2 2 0 2 1 0 0 1 1 1 2 2	1 1 2	3	
71	Gary Lucas Park Supt.	Liberal Praire	17000	0 0 0 0 0 2 0 1 0 0 0 1 0 0 0 1 0 1 4	* * *	4	
72	Karen Younce Chairman	Anthony Praire	3000	2 0 1 0 0 0 0 2 2 0 0 2 0 0 0 1 1 1 3	* * *	7	R-"Lawrence KA has excellent program"
73	Bill Turner Tree Board Mem.	Merriam For. Urb. City	12000	2 2 0 2 2 2 0 2 2 2 2 0 2 2 2 2 2 2 1	* * *	5	Newspaper attached
74	Edwin H. Kittner Mayor	Blue Rapids Praire	2100	2 2 2 2 2 0 0 2 2 0 2 2 2 2 2 2 2 2 2	* * *	1	Lawrence KA!!!
75	Greg Ruether City Forester	Overland Park Praire	95000	2 1 2 2 2 2 0 0 0 0 1 1 1 2 2 2 2 2 2	2 2 2	2	R-Quote on extension program use
	ARIZONA						
76	Donald E. Wommack Forestry Prof.	Flagstaff Cleared Forest	42000	2 * * * 2 * * * * * 2 2 * * * * * * 4	2 2 2	4	
	NEW MEXICO						
77	F.B. Feather Horticultrist	Univ. of NM Riv. Bench Desert	50000	0 0 0 1 1 0 0 0 0 0 1 1 1 1 1 1 1 1 4	2 2 3	1	
	NEVADA						
78	Jim Ross Park Tech. Supv.	Reno Sagebrush locale	110000	1 0 0 1 1 1 0 0 0 0 1 1 0 0 0 1 0 1 3	* * *	6	Need to Coordinate efforts
	LATE RESPONSES						

LEGEND

Indicators of Effective Tree Care
2 Yes, within the last 6 years
1 Yes
0 No
* No response

Rate Community/ Rate Manual
1 Excellent
2 Good
3 Average
4 Good

APPENDIX G

Tree Worker and Arborist Certification

This appendix contains information about state or region wide Arborist Certification programs. Such programs require a tremendous commitment from many people, and especially, a very strong "Arborist Association". With an active, strong association, and the support of local arborists, certification programs will succeed.

This information is included here to show what can happen with active, enthusiastic professional arborists.

KANSAS ARBORISTS ASSOCIATION CERTIFICATION

The Kansas Arborist Association has adopted the following philosophy regarding Certification of Arborists in the State of Kansas.

As an association we offer a training course which presents individuals with information, guidance, methods and illustrations utilizing practical experience to enable the enrollees to practice proper arboricultural procedures in their employment or for whatever purpose they desire. In addition, as an organization we also provide a voluntary State Certification program. In certifying arborists, we cannot guarantee that these individuals will practice proper arboricultural procedures. We can only certify that these individuals have been given and provided training with which they should be able to accomplish proper arboricultural practices. Therefore, we feel that only those individuals who are practicing arboricultural tasks for a majority of their business, employment, or operations and those who instruct or consult on arboricultural aspects shall be eligible to receive the title "Certified Kansas Arborist" as long as these individuals maintain their requirements for certification.

Any violations of proper arboricultural procedures by members or certified arborists is a violation of the ethics by which they agreed to abide and shall be subject to the scrutiny of the Board of Directors which could impose de-certification if it is deemed necessary. Kansas Arborist Association assumes no liability for the actions of its certified members.

KANSAS ARBORISTS ASSOCIATION
CERTIFICATION REQUIREMENTS AND QUALIFICATIONS

1. Successful completion of the Arborists Training Course conducted by the Kansas Arborists Association (KAA), a course in Arboriculture, or another acceptable course on training on proper tree care and maintenance. (Submit copy of diploma or transcript.)

2. Profess to a Code of Ethics for Certified Arborists by notarized signature of written documents.

3. Two years of practical experience applying sound and proper arboricultural practices.

4. Three references, two of which must be current KAA Certified Arborists. References must sign application form.

5. Insurance Requirements: A minimum of $50,000 Property Damage and $100,000 Personal Liability Insurance.
   A: Commercial arborists, those actively practicing tree related services as a business and who are the principal agent for the firm shall be required to supply the KAA with a valid Certification of Insurance.

   B: Government, Institutional and Educational employees and those employed by Commercial firms but who are not the principal owner shall have an appropriate supervisor write a letter to the KAA verifying the applicants employment and provide the KAA with the firm or organizations current Insurance Provider and valid policy number or a statement of appropriate backing.

6. Payment of annual certification fee ($15.00/year).

7. Current and annual membership in the Kansas Arborist Association ($10.00/year).

8. Payment of initial processing fee for certification ($15.00). (This fee will also be charged to any Certified Arborist who has failed to renew annual dues and fees by the deadline of April 1).

9. Recommendation and approval by the KAA Board of Directors.

CODE OF ETHICS
FOR
CERTIFIED ARBORISTS

The foundation of ethics is a moral philosophy of honesty, justice and courtesy with mutual interest among men. The canons set forth here are an expression of this philosophy. The arborist recognizes these canons, not in passive observance, but as dynamic principles guiding his conduct.

PROFESSIONALISM

1. I will utilize my knowledge and skills as an arborist for the benefit of society. I will cooperate in extending the effectiveness of arboriculture by interchanging information and experience with other arborists, and by contributing to the work of related societies, associations, schools, and publications.

2. I will advertise only in a dignified manner, setting forth in truthful and factual statements the services I am prepared to render for my prospective clients and for the public.

RELATIONS WITH THE PUBLIC

3. I will strive to increase my knowledge of arboriculture and the dissemination of this knowledge, and will discourage and condemn the spreading of untrue, unfair, and exaggerated statements concerning arboriculture.

4. I will not issue statements, criticism, or arguments on public policies related to arboriculture without indicating on whose behalf I am acting.

5. If serving as an expert witness on matters concerning arboriculture, I will base my testimony on known facts and without personal bias.

6. I will not express publically an opinion on a subject relating to arboriculture unless I am informed of the related facts, and will not distort or withhold data for the purpose of substantiating a point of view.

RELATIONS WITH CLIENTS AND EMPLOYERS

7. I will be loyal to my client or my employer and will faithfully perform my work and assignments.

8. I will give clients complete and fair estimates of work to be done, and upon completion, will furnish a complete accounting of work done and materials supplied.

9. I will practice tree topping only as an emergency measure or at the client's insistence after clearly explaining the consequences of such action, and presenting the proper alternative.

10. I will not, without the full knowledge and consent of my client or employer, have an interest in any business which may influence my judgement in regard to the work for which I am engaged.

11. I will engage, or advise my client or employer to engage other experts or specialists in arboriculture and related fields whenever the clients or employees interest would be best served by such actions, and will cooperate freely with them in their work.

RELATIONS WITH FELLOW ARBORISTS

12. I will strive to hold high standards of certification for arborists, and will encourage and actively help others achieve these standards.

13. I will not intentionally and without just cause, directly or indirectly, injure the reputation or business of another arborist.

14. I will not compete with another arborist on the basis of charges for work by underbidding through reduction of his quoted fee after being informed of the fee quoted by a competitor.

15. I will not use the advantages of a salaried position to compete unfairly with another arborist.

16. If I have substantiated evidence of unethical or fraudulent conduct concerning another arborist, I will present the information to the Kansas Arborists Association Board of Directors.

I hereby subscribe to the Code of Ethics for Certified Arborists as set forth by the Kansas Arborists Association and promise to uphold them to the best of my ability.

____
Signature

____
Date

____
Notary Date Seal

ARBORIST CERTIFICATION IN OHIO

by Sharon Lilly

Abstract. The Ohio Chapter of ISA has recently certified it's [stet] first 97 arborists. The first examination was the result of three years work. During that three-year period, representatives of many other chapters contacted the Ohio Chapter for information and advice about building a certification program. The Ohio Chapter researched many existing certification programs and adopted the strongest features of each. This article outlines the procedures followed in developing the Ohio Arborist Certification program. It may serve as a guideline for chapters planning certification.

Certification has become a major concern for arborists across the country. Many ISA chapters have the subject of certification under current study. The development of a certification program is a long and ongoing process. Those who have been involved can attest to the magnitude of the task.

The Ohio Chapter, after three years of hard work, is now enjoying the fruits of its labor. The first Ohio Arborist Certification examination was given in January and the program has "graduated" it's [stet] first 97 arborists.

In the past three years, representatives of several ISA chapters have written for advice and information about starting certification programs. This article outlines the procedure followed by the Ohio Chapter. It is offered to assist other chapters in developing certification programs. The experience of the Ohio Chapter may help others overcome some obstacles and avoid some pitfalls.

Preliminary Steps. When the board of directors of the Ohio Chapter first considered professional certification, there were many questions to be answered. Did Ohio arborists want or feel the need for certification? Should the Ohio Chapter be involved with certifying? What were the legal implications? How much would the program cost? An ad hoc committee was formed to investigate these issues. All phases of arboriculture were represented on the committee: commercial, utility, municipal, consulting, and university and technical school educators. Every effort was made to ensure that each point of view was given a voice. Several commercial arborists were on the committee since it was felt that they would be most affected by certification.

Survey. Our first step was to prepare a survey for distribution to chapter members. The survey briefly explained what a certification program would involve and the format it might take. The survey asked, "Are you in favor of certification of arborists in Ohio?" and, "Do you think that the Ohio Chapter should undertake the project?"

The response was overwhelming. More than 90% supported both propositions. Many offered additional comments detailing the need for such a program. Some felt that certification was long overdue; others asked to be involved in establishing the program.

Constitution and Bylaws. There was still some question whether it was appropriate for the ISA to be certifying arborists. The committee contacted the Urbana office to find out the official position. At that time, there was no plan for national involvement although the chapters were being encouraged to proceed. The committee was given the names of representatives of other chapters already involved with certification.

The Ohio Chapter's constitution and bylaws were carefully reviewed to ensure that there was no clause prohibiting or restricting such a program. Since certification would be an educational program and would promote professionalism in arboriculture, the committee felt it would be fitting for the chapter to be involved. Further research revealed that most professional certification programs were administered by similar organizations.

Background and Research. It was helpful to review what other chapters had already done. The Illinois Chapter was able to recommend a study that later proved to be very useful.

The Western Chapter seemed to have the strongest arborist certification program to date. They had written a study guide that was both popular and helpful. In addition, the Western Chapter was certifying both arborists and tree workers in a dual program.

However, it was the Ohio Nurserymen's Association that provided the most help to our certification committee. The ONA has developed a very strong and thorough certification program for landscape installers and nurserymen. The study guides for each of these programs are concise and informative. These programs have been running successfully for several years and the ONA staff was more than willing to give advice and consultation along the way.

Legal Implications. The committee sought legal advice concerning the implications of administering a certification program. The chapter's attorney, Victor Merullo, advised that there was ample precedent for certification in other professions. He cautioned that the program must be carefully established to avoid discrimination in any form. He offered to review the program upon completion and to help in any way possible.

Some excellent legal advice was obtained from a publication recommended by the Illinois Chapter entitled, "A Survey and Assessment of Voluntary Certification: A Study of the Concept, Application and Feasibility of Determining Occupational Competence"[1]. This study was prepared by William R. Nelson for the Illinois Landscape Contractors Association. The document should be required reading for any chapter involved with certification.

Nelson's study provides a basic "how to" for establishing and administering a certification program. Of particular significance is the section dealing with the legal implications of certification. This section summarizes the legal precedents for challenging certification programs in the courts. Though only a few court cases have been brought, the background will help committees to avoid a number of legal pitfalls.

All certification programs must comply with certain government regulations. There are two regulatory agencies involved in federal antitrust regulations, the Justice Department and the Federal Trade Commission. The laws are intended to assure free and unfettered competition. Therefore, if any organization establishes a certification program that, intentionally or not, excludes competitors or restrains free trade, it may be in violation of antitrust laws. Nelson's study goes a step further to outline the Justice Department's provisions for avoiding an antitrust challenge.

The United States Chamber of Commerce *Association Letter* published an article by Jerald R. Jacobs, "Professional Credentialing by Associations: Some Cases and Guidelines." Jacobs' guidelines have proven invaluable to the Ohio Chapter in establishing the requirements and criteria for certification. These guidelines are also included in Nelson's study.

Format and Administration. A great deal of care was necessary in formulating the structure of the certification program. Regulations concerning eligibility and requirements must be defensible and non-discriminating. All criteria must be reasonable and cannot restrict free trade or fair competition.

We decided that chapter membership should not be a requirement for eligibility. Excluding an individual who did not wish to join ISA from becoming certified was a constraint of trade. We also decided that requiring non-members to sign the ISA Code of Ethics, though desirable, could also be challenged, and could not be defended as a reasonable criterion for certification. However, since ISA was sponsoring and administering the program, we felt justified in charging a higher fee for non-members.

We also decided not to require residency in Ohio to become an Ohio Certified Arborist. Some arborists live outside Ohio yet practice in Ohio. In fact, the Ohio Chapter has quite a few members from other states.

The committee wanted a minimum experience (or education) requirement for eligibility. However, this provision would prove difficult to define. Would landscape maintenance work count? What about arboretum experience? Suppose the applicant

had been self-employed, doing a variety of yard, landscape and tree work. Rather than create a difficult and adversarial situation, the committee elected to certify arborists based on the examination alone.

The certification program must be voluntary. The ISA has no power to administer or enforce a mandatory program. Besides, licensing had been attempted and had failed in the past.

Certification would be for individuals only. There is no practical method for certifying a company. Also, we elected not to have a grandfather clause. For a certification program to be fair, valid and meaningful, only those that can pass the test should be able to use the title.

Board Proposal and Financing. A fee structure was developed to raise money from the sale of study guides, registration and recertification. The committee was confident that the program would be paying for itself within three years after testing began. Some seed money was required, however. Based on other programs, it was estimated that the initial costs would be around $5,000. We felt that if most of the labor was volunteer, the costs could be reduced significantly.

The board of directors approved the proposal and it's [stet] financing, although no money was budgeted the first year. Since most of the preliminary work involved planning and writing, costs were minimal. Most of the expenses were incurred in the year before testing began.

The ad hoc certification committee was subsequently given formal status as a standing committee. We were given responsibility for administering the program and for making policy decisions regarding certification.

A plan was developed in which the six committee members would serve three-year terms with two members to be replaced each year. The Ohio Chapter executive director would serve as the seventh committee member. In order to serve on the committee, an individual need be neither an ISA member nor a certified arborist. The proposed constitutional amendment was put to membership vote in a special ballot.

In the meantime, the original 14-member ad hoc committee was cut back to a core of experienced educators and practicing arborists. The smaller group began work to establish the foundation of the program, write the study guide, and build a bank of exam questions.

What is an Arborist? Although the question seems a bit pedantic, it was one of the toughest and most important questions the committee tackled. After many hours of debate, the committee was unable to agree on a workable definition. The crux of the issue was the determination of a testing level. In order to determine a minimum level of competence, the committee needed to decide what an arborist did.

The variation and range in job descriptions of an arborist made this a difficult task. Some arborists earn a living climbing trees, while others are strictly involved with consulting, and have many years of college behind them. The committee decided that the thrust of the program was to protect our clients and their trees. Thus, our target became the "tree expert" who recommends or provides care to trees.

Preparation of the Study Guide. The certification committee evaluated study guides produced by other certification groups. Many of them referred to an array of standard textbooks for detailed information. We felt that while many fine texts are available, many arborists do not have access to them. We estimated the cost of obtaining several of the most widely used texts to be a prohibitive $200. The committee wanted to provide the certification applicants with most of the basic background material necessary, and no single textbook served that purpose. Since we had neither the money nor the manpower to write a study guide from scratch, we decided to look at what was available from other sources. One very important consideration was the final cost to the arborist. Our goal was to keep the study guide price between $50 and $100.

We drew up an outline of study categories that included tree identification, plant selection and installation, anatomy and physiology, pruning, cabling and bracing, problem diagnosis and treatment, tree care and maintenance, safety and legal aspects. We felt that arborists should have some basic knowledge in each of these categories.

The committee was able to assemble a study packet in the form of a loose-leaf notebook containing a number of excellent but inexpensive publications. The study packet consists of Smithyman's *The Tree Worker's Manual*, the NAA and the ANSI Z133.1 standards. Also included are several Ohio State University Extension Service publications including *Ohio Trees*, bulletins covering insects, diseases and tree fertilization, and 35 "fact sheets" that each deal with a particular tree health problem or maintenance practice.

To tie the various publications together and cover some details not discussed in the materials provided, a study guide was drafted. The study guide emphasizes the importance of each area of study to the practicing arborist. The guide recommends reading within the study packet as well as in other appropriate references. It gives new information where applicable. The entire "Legal Aspects" section was written from scratch since none of the other references covered that material. Each section ends with some sample examination questions.

The Exam. The committee started building the question bank very early in the process. Members were asked to write examination questions between meetings. The questions were collected, put on computer, and sent out to each committee member for review. These "mail reviews" continued over a period of two years.

We felt that the validity of the test was most important. The exam must be relevant and meaningful. In other words, the questions must test what an arborist really needs to know. It is very easy to write questions that are overly technical or too detailed. Our goal was to write questions with a practical application and avoid testing reading comprehension or endurance.

Eventually we accumulated more than 500 questions that had survived the initial screening. We then convened a marathon meeting to carefully analyze each question. Some questions were discarded, while others were rewritten. We looked for any aspect that would make a question unclear, ambiguous, or otherwise invalid.

Our next step was to do a preliminary test. The committee lined up arborists with various backgrounds from all around the country. In all, 25 arborists took the sample test. They were all encouraged to make comments and note any questions that might need revision. Then they were asked to fill out a questionnaire about their experience and education in arboriculture. They were also asked to evaluate the test as to content, difficulty and balance of subject matter.

When all of the results were in, they were analyzed carefully. Each question was reviewed to determine the percentage that answered it correctly, and which answers were given when the question was answered incorrectly. All of the comments were noted and a few changes were made to clarify ambiguous statements. Overall, the comments indicated that the exam was on target for difficulty and balance, although a few thought it was too long at 200 questions. The preliminary testing provided us with some valuable input in preparing the exam.

The committee decided to shorten the exam to 175 multiple choice questions. The exam included 25 plant samples for identification and diagnosis. Approximately half of the written questions were core questions that would appear on each of the five exams. The remaining questions were distributed between the five.

Promotion. Each issue of the Ohio Chapter newsletter carried an announcement or article concerning certification. A brochure was developed to explain all of the details of the program. The brochure was distributed to arborists throughout the state. It was also available at all the chapter functions. Following the exam, a sample press release was sent to each certified arborist. Another press release was distributed to each of Ohio's major newspapers. The article contained a list of all of the local

arborists who passed the certification exam. A list of certified arborists was made available to urban foresters, county extension agents and city arborists throughout the state.

Truck stickers, patches and logo sheets were also prepared for those who passed the test. The Ohio Certified Arborist logo appeared with anything related to the program, or wherever it might help arborists become familiar with it.

The response to the certification program was much greater than expected. The word spread quickly, and most of the comments were positive. The first exam drew a capacity crowd. Applicants began reserving space in the second exam before the first was given. Best of all, perhaps, the program began to pay for itself after the first six months.

Seminar. Since the certification program was designed to be educational, we planned to give pre-testing seminars. The purpose was to review pertinent material and emphasize the latest information. The goal in certifying arborists was not to eliminate some from competition, but to establish a minimum level of competence. The more arborists certified, the better for the industry. On the other hand, the exam had to be stringent enough to be meaningful.

Recertification. The committee decided that certification should be for a period of three years. The idea was to encourage arborists to stay abreast of the latest research and recommendations. Recertification could be achieved either by reexamination, or by accumulating educational credits. The committee developed a list of approved seminars and workshops that could be attended for recertification credits. Three credits had to be obtained in the three-year period.

Summary: How to Build a Certification Program

1. Confirm that the membership of your organization, especially those that will be most affected, support the concept.
2. Thoroughly research and analyze existing trends in certification, and be aware of all pertinent laws and regulations.
3. Organize a strong and devoted committee to work on the project.
4. Prepare a budget. Include all foreseeable costs. Obtain the financial backing of the sponsoring organization.
5. Define the testing objectives and know the target group.
6. Prepare a study guide that will assist applications in preparing for the exam.
7. Prepare the exam. Carefully review each question. Analyze for readability, length, comprehension level and subject matter. Remember the most important factor is the exam's validity. The exam must test information that is an integral part of work performance and professional competency.
8. Plan each aspect of the program's administration with care. Avoid discriminatory policies, and provide equal opportunities for all members of the profession.
9. Promote the program within the industry as well as with the general public. Never endorse a specific certified individual over other arborists, although it is acceptable to endorse certified professionals in general.
10. The certifying board should be autonomous from the parent organization.

Literature Cited

1. Nelson, W.R. 1981. A Survey and Assessment of Voluntary Certification. Illinois Landscape Contractors Association, Lombard, Illinois.

EXPERT TREE SERVICE
251 Autumn Leaf Ct.
Worthington, Ohio 43235

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APPENDIX H

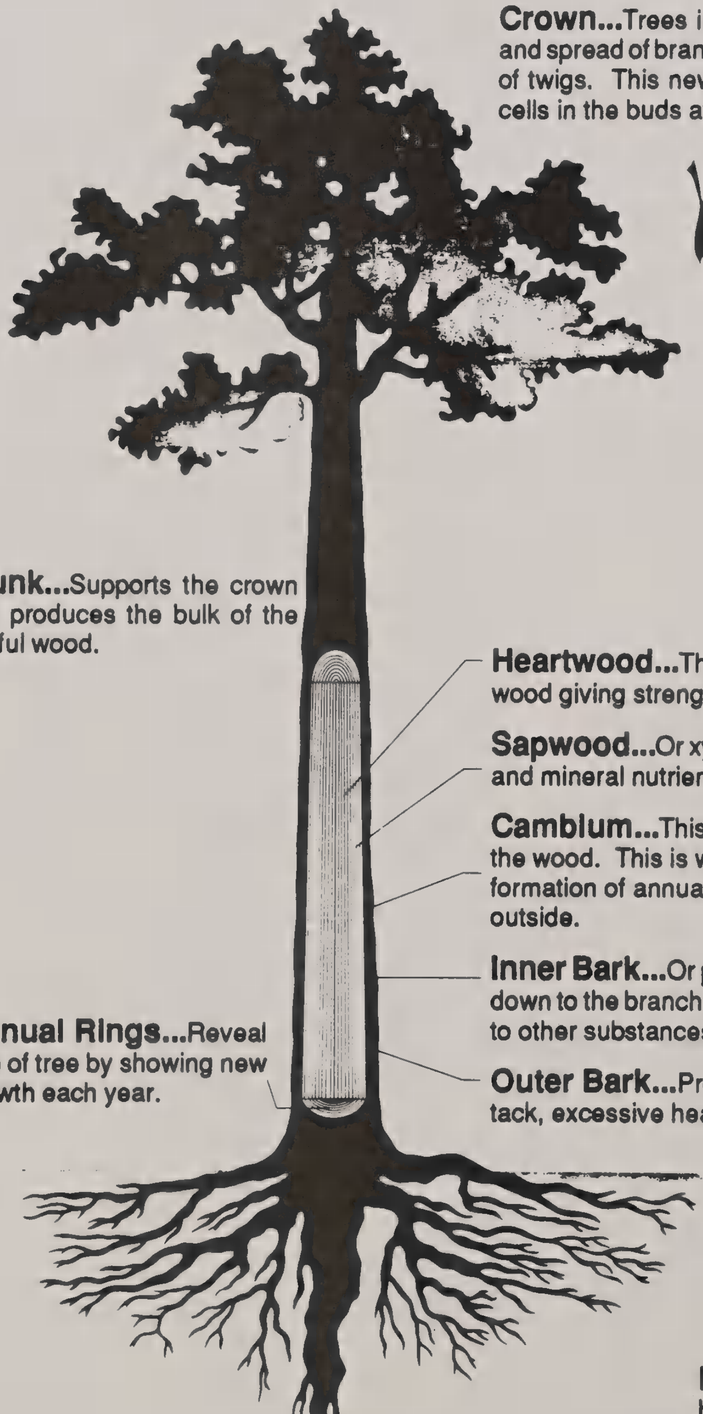
How a Tree Grows

HOW A TREE GROWS

Photosynthesis... Plant leaves are the most important chemical factories in the world. Without their basic product, sugar, there would be little food for man or animal, no wood for shelter, no humus for the soil, no coal for fuel.

Inside each leaf, millions of green-colored, microscopic particles (called chloroplasts) manufacture sugar. They trap radiant energy from sunlight for power. Their raw materials are carbon dioxide from the air and water from the soil. Oxygen, a by-product, is released. This fundamental energy-storing, sugar making process is called photosynthesis.

Enzymes... What happens to the sugar made in the leaf? With the aid of chemical activators (enzymes), every living cell--from root tips to crown top--goes to work on the sugar. New products result. Each enzyme does a certain job, working with split-second timing and in harmony with the others. In general, they break down sugar and recombine it with nitrogen and minerals to form other substances such as starches, fats, oils, and proteins, which help form fruits, nuts, and seeds. They also convert some sugar to cell-wall substances such as cellulose, lignin, and suberin, which make up wood and bark.



Crown... Trees increase each year in height and spread of branches by adding a new growth of twigs. This new growth comes from young cells in the buds at the ends of the twigs.

Leaves... Make food for the tree by combining carbon dioxide from the air and water from the soil, in the presence of sunlight, to form sugar.

Trunk... Supports the crown and produces the bulk of the useful wood.

Heartwood... This was once sapwood. It is now inactive wood giving strength and stiffness.

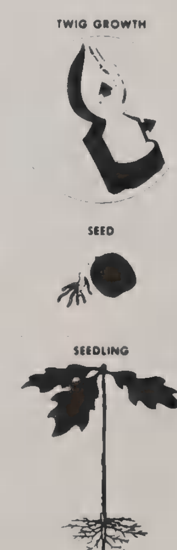
Sapwood... Or xylem, carries the sap (water plus nitrogen and mineral nutrients) from roots to the leaves.

Cambium... This is a layer of cells between the bark and the wood. This is where growth in diameter occurs with the formation of annual rings of new wood inside and new bark outside.

Inner Bark... Or phloem, carries sugar made in the leaves down to the branches, trunk, and roots, where it is converted to other substances vital for growth.

Annual Rings... Reveal age of tree by showing new growth each year.

Outer Bark... Protects tree from insects and disease attack, excessive heat and cold, and other injuries.



Root Hairs... Tubular in form, absorb water and nutrients from the soil.

Roots... Anchor the tree, transport water and nutrients, and help hold the soil against erosion.

HOW A TREE GROWS

Leaves of trees and other plants are the most important chemical factories in the world. Without the sugar plants make and the energy plants store, there would be little food for man or animal; no wood to build our homes or make furniture, tools, paper, and thousands of other products for vital human needs; no coal, petroleum or natural gas to heat our homes, offices and factories, or to power our cars, trucks, planes and trains; and no humus to enrich the soil. (Oil and much natural gas comes from deposits of tiny sea plants and animals.)

Without the oxygen which plants produce, there could be no animal life, including man.

Sunlight, air, water, and soil are the basic elements trees need to live and grow.

Sunlight provides the energy for the leaf "factories." In the leaves, water from the roots combines with **carbon dioxide** from the air to form simple sugars like **glucose**. This process is carried on inside each leaf by millions of green-colored, microscopic **chloroplasts**. Taken together, these tiny bodies are called **chlorophyll**; they give leaves their worldwide green color.

Oxygen is a byproduct of this process — a very vital byproduct — and is released into the air. This is how man and other animals get the oxygen they must have to breathe and exist. And the animals exhale carbon dioxide, which plants need just as badly, into the air where trees and other plants pick it up. Thus we see that plants and animals are completely dependent upon each other.

This fundamental manufacturing process is called **photosynthesis** (from "photo" meaning "light" and "synthesis" meaning "to put together").

THREE GROWING PARTS

Trees have three main growing parts — the **root tips**, the **stem tips**, and the **cambium layer** which is found between the bark and the wood throughout the tree. The growing points of the stems develops into branches, leaves, and flowers; the flowers become fruits or nuts, maturing into seeds. The cambium layer, only a single cell in width, divides into **xylem** or **sapwood** on the inside, and **phloem** or **bark** on the outside.

Trees increase each year in height and spread of branches by adding a new growth of twigs from young cells in the buds at the ends of the twigs.

The sapwood carries water and dissolved minerals (sap) up from the roots to the leaves, through a network of microscopic **vessels**. As the tree grows older, the sapwood becomes heartwood, the center core of the wood which is often darker in color. The wood gives the tree its strength and upright form, and furnishes man with countless thousands of essential and useful products. Most of the useful wood is in the **trunk**, which supports the leafy **crown**.

The inner bark has a special function which we will see in a moment. The outer bark, which gets thick and scaly with age, protects the tree from injuries of all kinds.

What happens to the all-important sugar made in the leaves?

It is carried by a network of tiny "pipes" (sieve tubes) in the inner bark to all living cells in the tree. Every living cell — from root tips to crown tips — goes to work on the sugar, with the aid of special **enzymes**, to make it into new products.

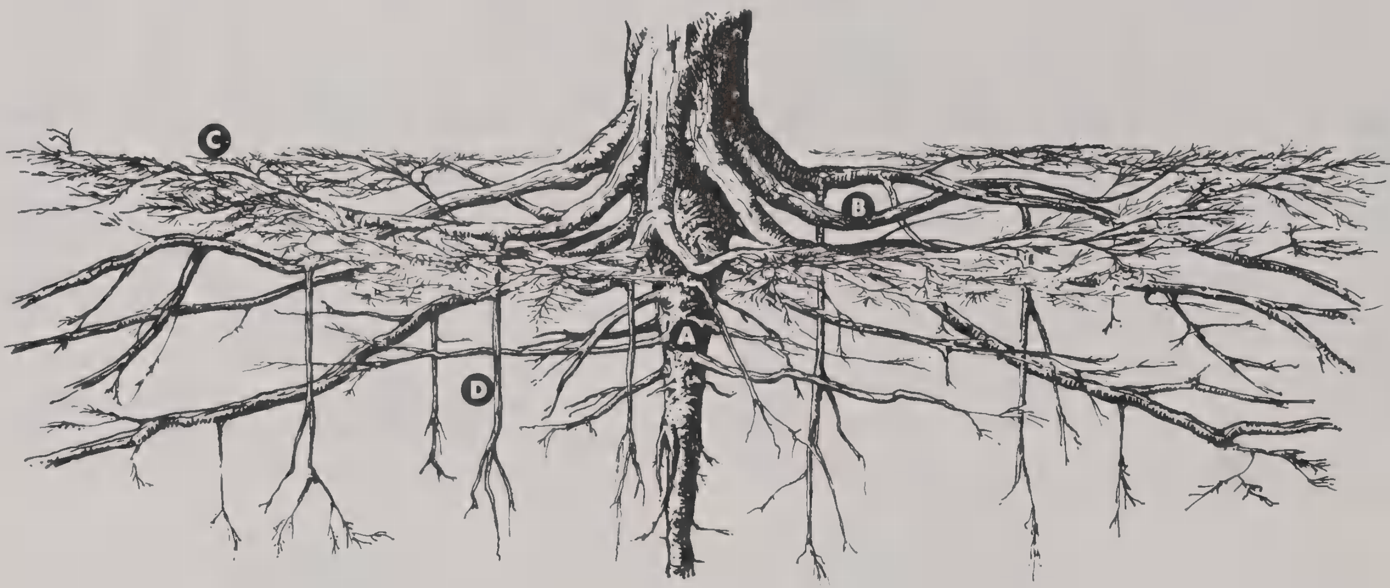
Enzymes start or speed up certain chemical reactions. Each enzyme does a special job, working with split-second timing and in harmony with the others. In general, the enzymes break down sugar and recombine it with the **nitrogen and minerals** which are dissolved in the water carried up from the root tips.

TREES MAKE FOODS

In this second manufacturing stage, some sugar is changed to other foods, some is made into new cells as the tree grows, and some is made into various special substances. Some sugar is used directly to provide the energy for growth in the buds, cambium layer, and root tips. Man taps hard maple trees for their sugary sap to make maple syrup and maple sugar.

Other foods made by the tree are **starches, fats, oils,** and **proteins** — all of which help to form flowers, fruits, nuts, and seeds, and may be also stored in the roots and wood during the dormant season. Seeds are sometimes dropped in great profusion, and help assure reproduction of the tree and the forest.

The new cells produced in this second process are principally the new wood and bark. The cell walls of the wood consist mainly of **cellulose fibers** and **lignin**. The cell walls of the bark are mainly cellulose and **suberin**. Lignin is a dark-colored chemical substance which seeps into the



Tap Root (A) — Provides main support of tree and anchors it firmly in the ground. (Not all trees have one)

Lateral Roots (B) — Help support and anchor trunk, may extend far out, beyond crown spread.

Fibrous Roots (C) — Masses of fine feeding roots close to ground surface.

Deeply Descending Roots ('Sinkers') (D) — Grow downward from lateral roots.

wood fibers and gives them extra hardness and strength. Suberin is as waxy, fatty substance which seeps into the looser, corky fibers of the bark and thus protects the living cells in the cambium area from drying out and dying, which would cause the death of the tree.

Some of the special substances made in the tree which have uses in industry are: rosin and turpentine from southern pines; chewing gum from chicle trees and spruces; tannin for leather-making from hemlocks, oaks, and chestnuts; vanillin for ice cream; birch beer; sassafras tea; chemicals used to make resins, plastics, rayon, photo film, etc.

It is curious that less than 1 percent of the water absorbed by the tree roots is required for the chemical process of photosynthesis. The remaining 99 percent-plus is **transpired** ("breathed" out as water vapor along with air) through the tiny openings, **stomata**, mostly on the underside of the leaves. However, this transpiration serves an important function. It helps to maintain the uniform cool temperature in the leaves which is needed for photosynthesis.

ROOT SYSTEM

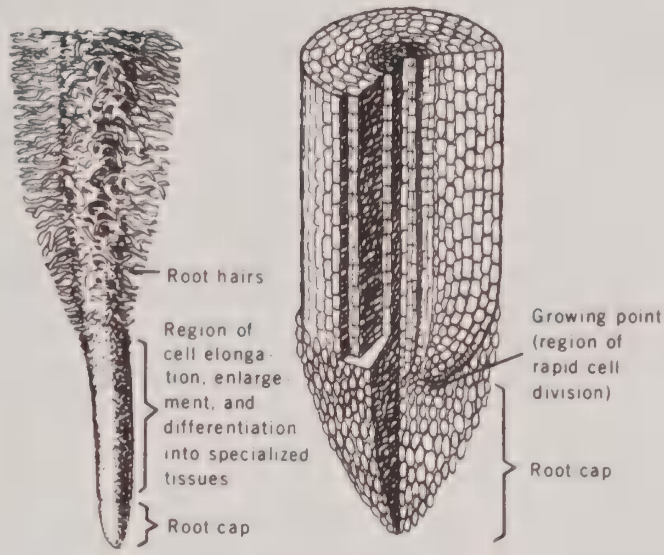
The root system sketched here is growing in a soil which has no rooting restrictions, such as shallow bedrock, or dense, compact clay layers. Note the big taproot and the many smaller lateral roots extending far out on each side — all of which give strong support to the tree and anchor it firmly in place. (Of course, many species of trees do not have taproots.) A few roots descend deeply into the soil from the lateral roots.

Some roots may extend down into the soil very deeply — often 12 feet and sometimes 30 feet or more. Lateral roots may extend from the trunk for long distances also — often 35 feet in each direction and sometimes much more. But most feeding roots are usually in the top 2 or 3 feet of soil. The kind of tree, its age, type of soil, moisture available, competing vegetation, and other factors determine the extent of the root system.

The growing root tips, very small but very numerous, each covered with a protective cap of cells, push into the soil to extend the many-branching root system (see enlarged sketches).

Just behind each tip is a dense fuzz of microscopic root hairs growing out all around the rootlet. It is these tiny root hairs which absorb the gallons and gallons of water and dissolved minerals which the tree needs each day during the growing season to live and grow. As the rootlet becomes longer and larger, the older hairs die and are sloughed off; new ones grow closer to the growing tip.

In a typical forest of the temperate zone, where the climate is neither extremely cold nor hot most of the year, nor excessively dry, the soil near the surface is loose, soft, easily crumbled, and usually moist. This natural mellowness is protected and maintained by a covering of fallen leaves, fruits, nuts, twigs, branches, and trunks in various stages of decay — which is called **litter** or **mulch**. This fall of litter averages over a ton per acre per year in the United States, and is often much more where growth is heavy. It also includes material from animals — feathers, fur, feces, and carcasses of insects, birds, mice, squirrels, etc.



Enlarged view of the end of the root.

Root tip greatly magnified.

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APPENDIX I

Funding a Community Forestry Program

FUNDING A PROGRAM

The trees in a community benefit all the citizens; therefore the system used to finance the community forestry program should spread the costs as equally as possible. "A financing system for a municipal tree program should be dependable, equitable, easily administered, and consistent with community priorities."

The ultimate goal of many community forestry programs is to become a part of the regular city government, with stable funding from **general tax revenues**. This may not be attainable because of city politics, a limited tax base, or because the city is already taxing at the levy limits. Competition for these dollars may be very keen. Other sources of funds should be considered: **Special levies** are similiar to general fund financing, but these funds can be collected expressly for the community forestry program. Like the general revenues, special levies spread the tax burden over the entire community, and they are easily administered. **Municipal revenue bonds** are used by communities to fund improvement projects. Bonding issues are rarely used to finance a community forestry program, but they can be used to fund specific projects. Street and utility improvement projects funded by bonding should always include items for tree removal, tree planting and early tree care.

Some communities use **direct billing** or **special assessments** to fund all or part of their tree care program. Direct billing requires homeowners to pay for tree care work on trees adjacent to their property. Special assessments pro-rate tree care, usually based on linear feet of street frontage. Special assessments may be paid over a period of years, somewhat buffering the property owner from large expenses.

Direct billing and special assessment, however, place the expense of tree management unfairly on those whose trees need the work, while the entire community derives benefit from the activities. For example, there is no advantage in removing a dead elm to its owner, yet that owner pays for the protection of everyone else's trees. The logic of these methods is very difficult to explain, especially to an irate, uncooperative owner who has to pay! Provisions are often made for collecting direct billings with property taxes, so the property owner cannot escape paying them. Rest assured, though, that collecting the bill in this manner is not easy, and in many cases costs more to process than the cost of the activity itself. Unless no other alternatives are available, avoid the use of special assessments and especially direct billing.

Special improvement districts (local or municipal improvement districts) are formed when a group of landowners in the district vote to assess themselves for improvements. Establishing special improvement districts requires a great deal of work, but such districts are likely to succeed because the property owners are committed to the project. This is an under used method of funding urban forestry programs, especially in areas where neighborhood groups are strong.

Fees and surcharges can be used to support tree care, especially when collected in connection with more costly trees. In areas of new construction, there are many opportunities to establish trees as part of the development. The community (the planning commission?) should seriously consider the desire for trees in the area. If trees are desired, special efforts should be made to require the builder or developer to do the planting. This cost will be passed on to the ultimate owner of the property, but the cost is usually so small in relation to the cost of the property that it is not noticed. Establishing trees at the time of property development allows the trees to begin providing benefits sooner. Often, tree planting will be delayed until after construction is completed and the contractor has left the site. When this happens, the opportunity to cooperate with the contractor and utilize construction equipment is lost.

If the community will plant the trees, funds must be available to purchase and plant them and to provide early tree maintenance. This funding could come from the general urban forestry budget, or better yet, from a charge placed upon new building permits. Part of this fee may be returned to homeowners if they plant appropriate trees in approved places. Many communities require that developers set aside land for parks and greenspaces and the developer establish trees and other vegetation on them. In business districts, where new construction is absent, a small surcharge may be added to business licenses to provide for tree care and planting.

There are references to communities that assess a fee for tree maintenance or planting permits. While this is a potential source of funding, it is one which should be used carefully. Gaining public acceptance of and compliance with a permit system is difficult enough without imposing a fee.

Grants and endowments can often be obtained by an aggressive, competent program. Community development blocks grants from federal monies made available to provide housing, an

improved urban environment, and better economic opportunities for low to moderate income people. Urban forestry programs provide the urban environment, and thus are eligible for funding. Usually, however, urban forestry is part of a larger "renewal" project. Private foundations may also support some urban forestry projects, especially those planned for special places such as parks, the main street, or the new local library. Like community block grants, private fundation funds are usually available for a specific task and time period. Therefore, these sources of funding should be used to supplement more stable funds for urban forestry programs.

In many areas, large corporations and private individuals **donate funds** for local improvements. It never hurts to ask. Many communities raise funds through the sale of wood products obtained as a result of tree maintenance. Firewood sales are often successful. They raise funds and they reduce the community's disposal costs. Provisions must be made for a place to store, price and sell the wood. Also, liability must be considered. Chips from branches may be used in city parks, sold to the public, or made available to the public at no charge. Salt Lake City, Utah collects and recycles newsprint, allocating the funds to a tree replacement program. Some communities sell hats, T-shirts, or even tree seedlings to fund their program. A fun run for trees can generate funds for the program. The Red Butte Gardens (the State Arboretum of Utah located on the University of Utah campus) hosts a series of summer concerts and several benefit dinners to support its programs. The opportunities are endless. Work to develop ideas that will succeed in your community.

Finally, do not overlook **In-kind donations**. Many tasks are accomplished using borrowed equipment and operators, and volunteer labor. Local construction firms may volunteer trucks and drivers to haul trees and mulch. Murray, Utah, has recruited football teams to plant trees. Volunteers can plant, water, and prune small trees, conduct parts of the inventory, and help in many other ways. Be aware that this help is only as good as its training, so some time must be set aside for teaching them how to do a good job. In-kind donations often require "finagling," but if carried out effectively, they can help to build lasting support for the program. For example, Worland, a small community in central Wyoming, used private donations and donated labor to plant over 200 trees in the city parks and on the golf course, a project which would otherwise have cost over $20,000. The scale of such donations depends upon the community and the efforts of the organizers: Sacramento (CA) Tree Foundation is an active group that plants thousands of trees each year.

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APPENDIX J

Urban Forestry and Tree Care Workshops

URBAN FORESTRY AND TREE CARE WORKSHOPS

Why workshops? Few city leaders and citizens know how to develop effective tree care programs or even how to best care for trees. Workshop instructors can create awareness of urban forestry programs and teach current methods of tree care. "How to" skills are best introduced in workshops and demonstration settings.

Who should attend? All interested persons should attend, but especially those involved in urban forestry programs or responsible for the care of publicly owned trees and commercial care of privately owned trees. Persons with such responsibilities often can help instruct or lead discussions and should receive special invitations. Invite tree care workers from nearby towns and from utility companies.

How are workshops planned and conducted? Workshop planners and facilitators can be selected from the State Urban Forestry Coordinators, Extension Foresters, Ornamental Horticultural Extension Specialists, City Foresters, commercial arborists, or others with educational and technical assistance duties. Planning should begin three months or more prior to the workshop. Planners and facilitators should identify the targeted audience and determine State and local urban forestry needs. Most cities and towns care for trees to some degree, but lack programs with elements such as multi-source budgets or scheduled tree maintenance. Similarly, tree workers may lack updated skills and private citizens may not receive helpful tree care instruction.

Schedule group lunches and allow for lengthy breaks to stimulate the sharing of information and to build associations. Participant question/answer and open discussion periods can further help resolve local problems.

What information is often presented? Agendas vary depending on State and local needs. Carefully consider information needs prior to the workshop. Is a superficial "awareness" of a topic needed, or does the audience need detailed information to actually do what is being instructed? State this clearly in promotional material to avoid getting the wrong audience.

Select qualified speakers, those who have actually done what they will teach. Give them sufficient time to cover their topic. It is better to cover a few topics thoroughly than to skim many topics.

Evaluate the workshop. How well did the message get across? What topics still need to to be addressed? How can the session be improved?

Involve the audience in the presentations. Sometimes a "student" will know more than the instructor. Capitalize on this, both during the session and in future sessions.

Use members of local tree care professional associations as instructors. These individuals care enough about their profession to be involved in it. The professional society is prompted and strengthed when its members are recognized as instructors. The goal of tree care education is not just to educate attenders, it is to promote and strengthen the overall quality of tree care in an area. Active, thriving tree care associations play a very crucial role in achieving this goal.

APPENDIX K

Salt Lake City Urban Forestry Ordinance

The Salt Lake City Urban Forestry Ordinance was produced by a diverse group of concerned citizens and city employees. It addresses the needs of a large city with many old trees. Parts of this ordinance may not address your community's needs. A customized approach is recommended. After considering your community's needs, read through this ordinance carefully. Include sections which are appropriate for your community. Add sections to address other needs. Above all, avoid the temptation to substitute your community for every "Salt Lake City" in the ordinance.

SALT LAKE CITY

URBAN FORESTRY ORDINANCE

URBAN FORESTRY DIVISION

PARKS & RECREATION DEPARTMENT

SALT LAKE CITY, UTAH

PALMER DePAULIS
MAYOR

SALT LAKE CITY CORPORATION
OFFICE OF THE MAYOR
324 SOUTH STATE STREET
FIFTH FLOOR, SUITE 500
SALT LAKE CITY, UTAH 84111
535-7704

February, 1989

Dear Fellow Citizens:

Trees are a valuable resource in our community and contribute significantly to making Salt Lake City a more enjoyable place in which to live, work and relax. Today our city's "urban forest" is comprised of thousands of trees that grow along streets, in parks, cemeteries, homeowners' yards, and on school grounds and other public and private property. Unlike trees in naturally forested areas, most of our city trees have been planted since the pioneer settlers came to this valley in 1847.

Salt Lake City has an active urban forestry program to plan and manage our trees for social, economic and environmental benefit. An integral component of this program is the Urban Forestry Ordinance, adopted by the Salt Lake City Council on November 15, 1988. This ordinance will insure that our trees are properly protected and that our urban forestry program is consistently administered over many years.

Every tree in our city makes a difference because we see and benefit from them daily. A community rich in trees and landscape has a personality and character all its own, and graphically illustrates the commitment of our citizens in making Salt Lake City a pleasant and healthy place to live.

As Mayor of our city, I urge you to be involved in the proper planting and care of the urban forest. As a taxpayer, you are part owner of our city's trees. It is my hope that we can all work together to maintain and enjoy the benefits provided by our urban forest.

Sincerely,

Palmer DePaulis

Mayor Palmer DePaulis

Chapter 2.26

URBAN FORESTRY BOARD

Sections:

2.26.010 Purpose.

The city council and mayor of the city recognize the importance of the urban forest to the quality of life in the city. The city council and mayor declare it to be a policy of the city that city property be landscaped to enhance the natural beauty of the city; that the responsibilities of city departments be coordinated to encourage quality landscaping; that landscaped city property be effectively managed; that the street environment be made hospitable through landscaping; and

that residents of the city be encouraged to participate in beautification efforts through installing and maintaining quality landscaping on private property. To fulfill this policy, this chapter is enacted and intended to establish a Salt Lake City Urban Forestry Ordinance. This chapter may be referred to as the "Salt Lake City Urban Forestry Ordinance." (Ord. 75-88 § 1 (part), 1988: prior code § 25-29-1)

2.26.020 Definitions.

For the purpose of this chapter the following terms, phrases, words, and their derivations shall have the meaning given in this section:

A. "Parking/planting strip" means the area between the curb and sidewalk and the area between sidewalk and private property line that is city-owned property; unpaved streetside city property; or an area inside the private property line where an easement is given to the city for the purpose of planting trees.

B. "Private trees" means any and all trees growing on private property within the city limits as of or after the effective date of the ordinance from which this section or successor sections derives and which are not defined or designated in this chapter as street trees, park trees or public trees.

C. "Public trees" means all trees growing on any street, park, or any public place owned and/or managed by Salt Lake City as of or after the effective date of the ordinance codified in this chapter or its successor ordinances.

D. "Public right-of-way" means a portion of property reserved for public use and accepted for such use by the city to provide circulation and travel to abutting properties, including, but not limited to, streets, alleys, sidewalks, provisions for public utilities, cut and fill slopes, and open public spaces.

E. "Public utility" means any public, private or cooperatively owned line, facility or system for producing, transmitting or distributing communications, power, electricity, light, heat, gas, oil products, water, waste or stormwater, which directly or indirectly serves the public or any part thereof within the corporate limits of the city.

F. "Tree topping" means the specific reduction in the overall size of a tree and/or the severe cutting back of branches or limbs to such a degree so as to remove the normal canopy and disfigure the tree.

G. "Urban forester" means the city urban forester who is selected by the director of parks to that position in the parks and recreation department.

H. "Urban forestry program" means the program which is a part of the parks and recreation department and which is responsible for the care and maintenance of the urban forest resources located on city property. (Ord. 75-88 § 1 (part), 1988: prior code § 25-29-2)

2.26.030 Creation of board.

There is created the city urban forestry board, hereinafter referred to as the "board." (Prior code § 25-29-3)

2.26.040 Eligibility for membership.

A person appointed as a member of the board shall be a resident of the state. Board members shall be individuals who are actively interested in the improvement of the city's urban forest. Members representing each of the council districts must reside in the district. (Prior code § 25-29-10)

2.26.050 Appointments.

The board shall consist of nine voting members to be appointed by the mayor with the advice and consent of the council in the following manner:

A. One member from each of the seven city council districts, one member representing the central business district, and one member representing the sugar house business district. Of the members first appointed, the mayor shall designate three to serve for a term of one year, three to serve for a term of two years, and three to serve for a term of three years. Thereafter, as terms expire, all appointments shall be for terms of

-K3-

three years. Voting members shall serve no more than two consecutive terms on the board.

B. The city engineer and planning director shall serve as ex officio members of the board.

C. The urban forester shall serve as administrative staff to the board. Clerical staff shall be provided by the parks department. (Prior code § 25-29-4)

2.26.060 Oath of office.

To accept this appointment, members of the urban forestry board shall sign the oath of office required by law to be signed by city officials and file the same in the office of the city recorder. Any member who shall fail to file his or her oath of office within ten days after notification of such member's appointment shall be deemed to have declined such appointment. Another person shall be appointed to the vacant position in the manner prescribed in this code. (Prior code § 25-29-6)

2.26.070 Compensation.

Members of the board shall receive no compensation for their services. (Prior code § 25-29-5)

2.26.080 Vacancies.

Vacancies occurring in the membership of the board shall be filled in a manner preserving the designated representation by mayoral appointment, with the advice and consent of the council, for the unexpired term. (Prior code § 25-29-7)

2.26.090 Removal from office.

Any member may be removed from office by the mayor for cause, prior to the normal expiration of the term for which such member was appointed. (Prior code § 25-29-8)

2.26.100 Member's ethics.

Members shall be subject to and bound by the provisions of the Chapter 2.44 of this title, or its successor. Any violation of the provisions of such chapter shall be grounds for removal from office.

(Prior code § 25-29-9)

2.26.110 Meetings.

A. The board shall hold regular monthly meetings. The board shall hold its meetings in compliance with the State Open and Public Meetings Act.

B. Special meetings may be called by a majority of the board members, the chairperson or the mayor. The call for a special meeting must be signed by the parties calling such meeting and, unless waived in writing, each member not joining in the call for such special meeting must be given not less than three hours notice. The notice shall be served personally or left at the member's residence or business office.

C. Five members of the board shall constitute a quorum for the transaction of business. The board may act officially by an affirmative vote of any five of the members.

D. The parks department shall make available a secretary to the board through the urban forester. Meetings shall be held at a public place as designated by the board.

E. The board shall cause minutes of its proceedings to be kept which shall be available for public inspection in the office of the director of parks. The board shall record the yea and nay votes on any action taken by it.

F. The board shall adopt a system of rules of procedure under which its meetings are to be held. The board may suspend the rules of procedure by two-thirds vote of the members of the board who are present at the meeting. The board shall not suspend the rules of procedure beyond the duration of the meeting at which the suspension of the rules occurs. (Prior code § 25-29-11)

2.26.120 Election of board officers.

Each year the board at its first regular meeting after January 1st shall select one of its members as chairperson and another of its members as vice-chairperson, who shall perform the duties of the chairperson during the absence or disability of the chairperson. No member shall serve more

than two consecutive terms as chairperson. (Prior code § 25-29-12)

2.26.130 Committees.

The board may designate ad hoc subcommittees as it deems appropriate and advisable to study, consider and make recommendations on matters which are presented to the board. If the board desires nonmembers to serve on a subcommittee, it may request the mayor to make such appointments. Members of subcommittees will also serve without compensation. (Prior code § 25-29-14)

2.26.140 Attorney duties.

The city attorney shall be the attorney for the board. (Prior code § 26-29-16)

2.26.150 Powers and duties.

The board shall have the following powers and duties:

A. Determine and establish such rules and regulations for the conduct of the board as the members shall deem advisable; provided, however, that such rules and regulations shall not be in conflict with this chapter or other city, state or federal law;

B. Recommend the adoption and alteration of all rules, regulations and ordinances which it shall from time to time deem in the public interest and most likely to enhance and beautify the urban forest, and for the purposes of carrying out this chapter;

C. Recommend the broad matters of policy regarding the planting, maintenance and removal of trees and other vegetation on city property;

D. Recommend policies for the review and approval of capital projects where trees or other vegetation will be planted or removed on city property;

E. Recommend policies for the review and approval of projects on private property where open space and/or landscaping is required as a condition for the development, and recommend policies for the enforcement of approved plans;

F. Assist the urban forester in encouraging landscaping installation and maintenance on private property by providing information on the value of landscaping and on the proper planting and care of trees and other vegetation;

G. Identify landscaping projects that will enhance the urban forest and advocate incorporation of the projects into the capital planning process;

H. Recommend policies and procedures to identify, mark, publicize and preserve historic and notable trees on both public and private property;

I. Assist the urban forester in promoting appreciation of trees and the urban forest through annual Arbor Day observances and other activities;

J. Review those portions of the city budget allocated for the planting and care of trees and other vegetation, and advise the mayor on the appropriateness of the funding levels;

K. Whenever a vacancy occurs in the position of urban forester, recommend a procedure to select a replacement;

L. Encourage improvement of the urban forest through planning and policy development;

M. Assist city departments in every way possible to enhance the urban forest in the city;

N. In all instances, serve as an advocate of the city's urban forest. (Ord. 75-88 § 1 (part), 1988: prior code § 25-29-15)

2.26.160 Creation of urban forester position.

The city shall employ a person to be known as the "urban forester," whose specified duties, responsibilities and authority are specified in this chapter. (Ord. 75-88 § 1 (part), 1988: prior code § 25-29-13)

2.26.170 Powers and duties of urban forester.

The urban forester shall be the supervisor of the urban forestry program of the parks and recreation department and shall be responsible to the director of the parks and recreation depart-

ment in carrying out the duties of this position. The urban forester shall initiate an urban forest management plan. (Ord. 75-88 § 1 (part), 1988)

2.26.180 Rules and regulations.

The urban forester may recommend, and the mayor may adopt, additional regulations to be known as the urban forestry standards and specifications proper and necessary to effectuate the urban forest management plan within the city providing reasonable guidance for planting and maintaining public trees. Such rules and regulations shall not be in conflict with any other law or ordinance. (Ord. 75-88 § 1 (part), 1988)

2.26.190 Street trees—Private property owner responsibilities.

Any owner of private property, abutting city parking/planting strips upon which street trees are located, shall have the following responsibilities:

A. Periodic watering and fertilization of street trees when necessary to maintain good health and vigor;

B. Protection of street trees against damage caused by lawnmowers, weed trimmers, snowblowers and similar equipment. (Ord. 75-88 § 1 (part), 1988)

2.26.200 Street/public trees—Private property owner requests.

In cases where an owner of private real prpoerty abutting city property requests city actions on street trees or public trees, the requesting owner shall be financially responsible for the following:

A. Removal of trees, limbs or roots preventing house moving or other construction activities;

B. Removal of trees, limbs or roots for the alteration of tree or abutting property appearance where no hazard or nuisance exists;

C. Spraying, fertilizing or treatment other than may be regularly conducted on a city-wide basis by the city.

Financial responsibility does not eliminate the requirement of obtaining necessary permits required by this chapter. (Ord. 75-88 § 1 (part), 1988)

2.26.210 Landscape permit for public right-of-way.

It is unlawful for any person to plant, prune or remove any public tree, without first obtaining a permit from the parks department. Permits shall not be required for work performed by city personnel.

A. Planting and maintaining public trees: The Salt Lake City Urban Forestry Standards and Specifications shall be used as a guideline for planting and pruning public trees.

B. Removing trees: The urban forester must approve any permit for removal of public trees and as a condition, the permittee may be required to compensate the city for the value of the tree(s) removed either by replacement thereof or by monetary assessment.

C. Commercial companies, public utilities or individuals employed in the landscaping or arboricultural business shall be required to pay a permit fee of fifteen dollars per job or seventy-five dollars per year. (Ord. 75-88 § 1 (part), 1988)

2.26.220 Conditional use permits.

Where an application for a conditional use is filed with the board of adjustment on zoning and the board of adjustment deems it appropriate, the urban forester shall review the landscape improvement design of any conditional use application and make recommendations to the board. (Ord. 75-88 § 1 (part), 1988)

2.26.230 Public nuisance defined and designated.

The following are defined and declared to be public nuisances under this chapter:

A. Any tree or shrub located on private property having a destructive or communicable disease or other pestilence which endangers the growth, health, life or well-being of trees, shrubs

or plants in the city or which is acapable of causing an epidemic spread of a communicable disease or insect infestation;

B. The roots of any tree or shrub, located on private property, which cause the surface of the public street, curb or sidewalk to be upheaved or otherwise disturbed;

C. Any tree, shrub or portion thereof located on private property which, by reason of location or condition, constitutes an imminent danger to the health, safety or well-being of the general public on city property. (Ord. 75-88 § 1 (part), 1988)

2.26.240 Responsibility for public nuisance fixed.

Where a nuisance exists upon property, and is the outgrowth of the usual, natural or necessary use of property, the landlord thereof, or his or her agent, the tenant or his or her agent, and all other persons having control of the property on which such nuisance exists, shall be deemed to be the authors thereof, and shall be equally liable therefor. (Ord. 75-88 § 1 (part), 1988)

2.26.250 Nuisance creation and maintenance.

It is unlawful for any person, either as owner, agent or occupant, to create or aid in creating or contributing to or to maintain a public nuisance. (Ord. 75-88 § 1 (part), 1988)

2.26.260 Nuisance abatement.

The city shall ascertain and may cause all nuisances declared to be such by this chapter to be abated. (Ord. 75-88 § 1 (part), 1988)

2.26.270 Notice to abate.

Except as provided in Section 2.26.260 or its successor, the city may serve a notice in writing upon the owner, occupant or agent of any lot, building or premises in or upon which a nuisance may be found, or upon the person who may be the cause of such nuisance,a requiring the person to abate the nuisance within a fourteen-day period. Failure to give a notice as provided herein shall not relieve the author of any nuisance from the obligation to abate such nuisance, or from the penalty provided for the maintenance thereof. Notice of appeal may be filed with the parks director within fourteen days of service of notice. Appeals from the park director's decision shall be heard by a hearing officer designated by the mayor within fourteen days. (Ord. 75-88 § 1 (part), 1988)

2.26.280 Expense of abatement—Responsibility of offender.

In case of neglect or refusal of any person to abate any nuisance defined by this chapter, after notice in writing has been served upon them, as provided in this chapter, and within the time specified in the notice, the city may abate or procure the abatement thereof, and the expense of such abatement shall be collected from the person so offending. (Ord. 75-88 § 1 (part), 1988)

2.26.290 Abuse or mutilation of public trees.

It is unlawful for any person to damage, transplant, top, remove or mutilate any tree on public property. (Ord. 75-88 § 1 (part), 1988)

2.26.300 Protection of public trees near construction activities.

Any tree located on city property in the immediate vicinity of any excavation, demolition or construction site of any building, structure, street or utilities work, which has potential for injury, shall be protected from such injury. (Ord. 75-88 § 1 (part), 1988)

2.26.310 Tree topping.

It is unlawful for any person or firm to top, dehorn or pollard any public tree. Trees severely damaged by storms or other causes, or trees creating emergency hazardous situations, are exempt from this section. Trees under utility wires or other obstructions where standard pruning practices are impossible may be exempted from this section with the prior written approval of the director of parks and recreation. (Ord. 75-88 § 1 (part), 1988)

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APPENDIX L

Pruning Standards, International Society of Arboriculture, Western Chapter, 1988 Version

PRUNING STANDARDS

INTERNATIONAL SOCIETY OF ARBORICULTURE

Western Chapter

California - Arizona - Hawaii - Nevada

Certification Committee - P.O.Box 424 - St. Helena, California 94574

Written by: WC ISA Certification Committee
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Steve Holcomb
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Fred Roth

These Standards address pruning in terms of tree growth and response. They are not intended as a training manual for pruning or climbing techniques. Tree pruning is often dangerous, with unseen hazards. Proper training in safe work practices and supervision is required for tree climbing. It is the tree worker's responsibility to exercise adequate precautions for safety. All tree maintenance must be performed in compliance with ANSI Z133.1, 1988 Safety Standards.

PRUNING STANDARDS

Purpose:

Trees and other woody plants respond in specific and predictable ways to pruning and other maintenance practices. Careful study of these responses has led to pruning practices which best preserve and enhance the beauty, structural integrity, and functional value of trees.

In an effort to promote practices which encourage the preservation of tree structure and health, the W.C. ISA Certification Committee has established the following Standards of Pruning for Certified Arborists. The Standards are presented as working guidelines, recognizing that trees are individually unique in form and structure, and that their pruning needs may not always fit strict rules. The Certified Arborist must take responsibility for special pruning practices that vary greatly from these Standards.

I. Pruning Techniques

A. A thinning cut removes a branch at its point of attachment or shortens it to a lateral large enough to assume the terminal role. Thinning opens up a tree, reduces weight on heavy limbs, can reduce a tree's height, distributes ensuing invigoration throughout a tree, and helps retain the tree's natural shape. Thinning cuts are, therefore, preferred in tree pruning.

   When shortening a branch or leader, the lateral to which it is cut should be at least one-half the diameter of the cut being made. Removal of a branch or leader back to a sufficiently large lateral is often called "drop crotching."

B. A heading cut removes a branch to a stub, a bud, or a lateral branch not large enough to assume the terminal role. Heading cuts should seldom be used because vigorous, weakly attached upright sprouts are forced just below such cuts, and the tree's natural form is altered. In some situations, branch stubs die or produce only weak sprouts.

C. When removing a live branch, pruning cuts should be made in branch tissue just outside the branch bark ridge and collar, which are trunk tissue. *(Figure 1)* If no collar is visible, the angle of the cut should approximate the angle formed by the branch bark ridge and the trunk. *(Figure 2)*

D. When removing a dead branch, the final cut should be made outside the collar of live callus tissue. If the collar has grown out along the branch stub, only the dead stub should be removed, the live collar should remain intact, and uninjured. *(Figure 3)*

E. When reducing the length of a branch or the height of a leader, the final cut should be made just beyond (without violating) the branch bark ridge of the branch being cut to. The cut should approximately bisect the angle formed by the branch bark ridge and an imaginary line perpendicular to the trunk or branch cut. *(Figure 4)*

F. A goal of structural pruning is to maintain the size of lateral branches to less than three-fourths the diameter of the parent branch or trunk. If the branch is codominant or close to the size of the parent branch, thin the branch's foliage by 15 percent to 25 percent, particularly near the terminal. Thin the parent branch less, if at all. This will allow the parent branch to grow at a faster rate, will reduce the weight of the lateral branch, slow its total growth, and develop a stronger branch attachment. If this does not appear appropriate, the branch should be completely removed or shortened to a large lateral. *(Figure 5)*

G. On large-growing trees, except whorl-branching conifers, branches that are more than one-third the diameter of the trunk should be spaced along the trunk at least 18 inches apart, on center. If this is not possible because of the present size of the tree, such branches should have their foliage thinned 15 percent to 25 percent, particularly near their terminals. *(Figure 6)*

H. Pruning cuts should be clean and smooth with the bark at the edge of the cut firmly attached to the wood.

I. Large or heavy branches that cannot be thrown clear, should be lowered on ropes to prevent injury to the tree or other property.

J. Wound dressings and tree paints have not been shown to be effective in preventing or reducing decay. They are, therefore, not recommended for routine use when pruning.

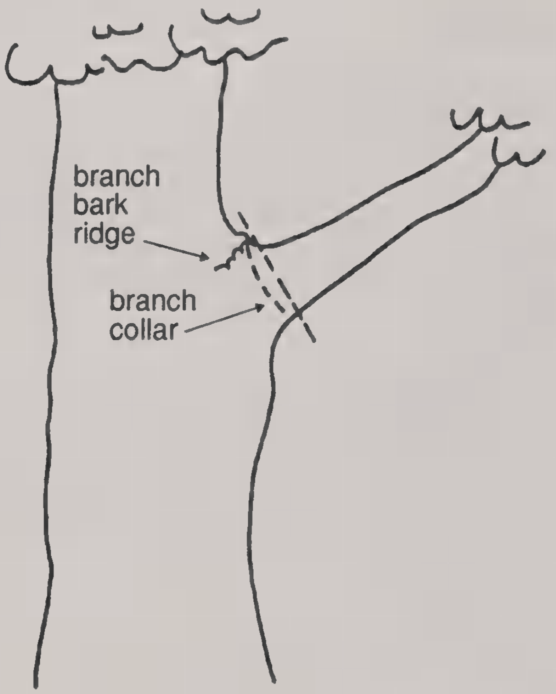


FIGURE 1: When removing a branch, the final cut should be just outside the branch bark ridge and collar.

FIGURE 2: In removing a limb without a branch collar, the angle of the final cut to the branch bark ridge should approximate the angle the branch bark ridge forms with the limb. Angle AB should equal Angle BC.

FIGURE 3: When removing a dead branch, cut outside the callus tissue that has begun to form around the branch.

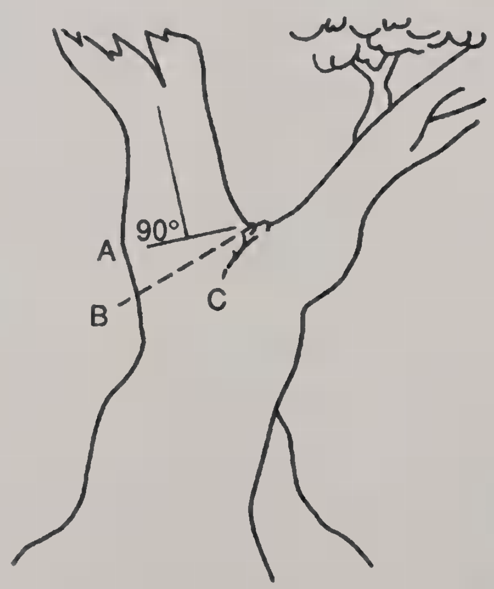


FIGURE 4: In removing the end of a limb to a large lateral branch, the final cut is made along a line that bisects the angle between the branch bark ridge and a line perpendicular to the limb being removed. Angle AB is equal to Angle BC.

FIGURE 5: A tree with limbs tending to be equal-sized, or codominant. Limbs marked B are greater than 3/4 the size of the parent limb A. Thin the foliage of branch B more than branch A to slow its growth and develop a stronger branch attachment.

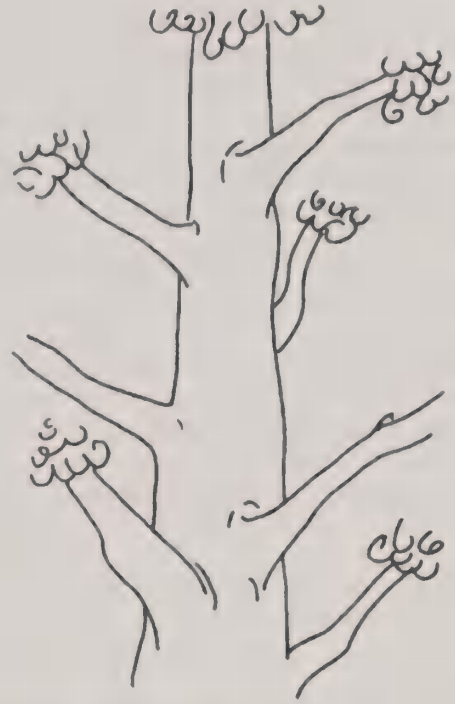


FIGURE 6: Major branches should be well spaced both along and around the stem.

II. TYPES OF PRUNING--MATURE TREES

A. CROWN CLEANING: Crown cleaning or cleaning out is the removal of dead, dying, diseased, crowded, weakly attached, and low-vigor branches and watersprouts from a tree crown.

B. CROWN THINNING: Crown thinning includes crown cleaning and the selective removal of branches to increase light penetration and air movement into the crown. Increased light and air stimulates and maintains interior foliage, which in turn improves branch taper and strength. Thinning reduces the wind-sail effect of the crown and the weight of heavy limbs. Thinning the crown can emphasize the structural beauty of trunk and branches as well as improve the growth of plants beneath the tree by increasing light penetration. When thinning the crown of mature trees, seldom should more than one-third of the live foliage be removed.

At least one-half of the foliage should be on branches that arise in the lower two-thirds of the trees. Likewise, when thinning laterals from a limb, an effort should be made to retain inner lateral branches and leave the same distribution of foliage along the branch. Trees and branches so pruned will have stress more evenly distributed throughout the tree or along a branch.

An effect known as "lion's tailing" results from pruning out the inside lateral branches. Lion's-tailing, by removing all the inner foliage, displaces the weight to the ends of the branches and may result in sunburned branches, watersprouts, weakened branch structure, and limb breakage.

C. CROWN REDUCTION: Crown reduction is used to reduce the height and/or spread of a tree. Thinning cuts are most effective in maintaining the structural integrity and natural form of a tree and in delaying the time when it will need to be pruned again. The lateral to which a branch or trunk is cut should be at least one-half the diameter of the cut being made.

D. CROWN RESTORATION: Crown restoration can improve the structure and appearance of trees that have been topped or severely pruned using heading cuts. One to three sprouts on main branch stubs should be selected to reform a more natural appearing crown. Selected vigorous sprouts may need to be thinned to a lateral, or even headed, to control length growth in order to ensure adequate attachment for the size of the sprout. Restoration may require several prunings over a number of years.

E. CROWN RAISING: Crown raising removes the lower branches of a tree in order to provide clearance for buildings, vehicles, pedestrians, and vistas. It is important that a tree have at least one-half of its foliage on branches that originate in the lower two-thirds of its crown to ensure a well-formed, tapered structure, and to uniformly distribute stress within a tree.

When pruning for view, it is preferable to develop "windows" through the foliage of the tree, rather than to severely raise or reduce the crown.

III. SIZE OF PRUNING CUTS

Each of the Pruning Techniques (Sectin I) and Types of Pruning (Section II) can be done to different levels of detail or refinement. The removal of many small branches rather that a few large branch will require more time, but will produce a less-prunded appearance, will force fewer watersprouts, and will help to maintain the vitality and structure of the tree. Designating the maximum size (base diameter) that any occasional undesirable branch may be left within the tree crown, such as 1/2", 1", or 2" branch diameter, will establish the degree of pruning desired.

IV. CLIMBING TECHNIQUES

A. Climbing and pruning practices should not injure the tree except for the pruning cuts.

B. Climbing spurs or gaffs should not be used when pruning a tree, unless the branches are more than throw-line distance apart. In such cases, the spurs should be removed once the climber is tied in.

C. Spurs may be used to reach an injured climber and when removing a tree.

D. Rope injury to thin barked trees from loading out heavy limbs should be avoided by installing a block in the tree to carry the load. This technique may also be used to reduce injury to a crotch from the climber's line.

APPENDIX M

American Standard for Nursery Stock

ANSI
Z60.1-1986
Revision of
Z60.1-1949 (R1980)

AMERICAN STANDARD FOR NURSERY STOCK

Sponsor:
American Association of Nurserymen, Inc.

Approved May 2, 1986
American National Standards Institute, Inc.

ABSTRACT

Nurserymen, landscape architects, landscape contractors and others trading in or specifying nursery plants have assisted in developing these standards for the various kinds of nursery plants to facilitate the commerce in nursery stock. Illustrations, examples, and written descriptions have been combined to clarify the standards.

1 SHADE & FLOWERING TREES

This section applies to plants generally sold to the retail and landscape trade. For liner grades see section 6.

1.1 GENERAL SPECIFICATIONS

1.1.1 CALIPER AND HEIGHT MEASUREMENT

In size grading B&B trees, caliper shall take precedence over height.

In size grading bare root trees, height shall take precedence to 6 feet for Tree Type 3 and 4 and to 8 feet for Trees Types 1 and 2; thereafter, caliper takes precedence.

Caliper of the trunk shall be taken 6 inches above the ground up to and including 4-inch caliper size, and 12 inches above the ground for larger sizes.

Seldom are tree trunks perfectly round. Caliper measurement may be taken with "slot" type caliper, "pincer" type caliper or diameter tape.

For purposes of simplicity, only one size per "grade" will be listed. That size will be the minimum size allowable for that grade and shall include plants from that size up to but not including the next larger grade size.

Example: *Acer rubrum*, 2 inch caliper. This could include *Acer rubrum* calipering 2 inches up to but not including 2½ inches in caliper, measured 6 inches above the ground line.

1.1.2 HEIGHT OF BRANCHING—STREET TREES

Bid specifications for trees for street plantings should specify the height to which the tree should be free of branching. Height of branching should bear a relationship to the size and kind of tree, also, so that the crown of the tree will be in good balance with the trunk as the tree grows.

Examples:

Acer platanoides, 2 in. cal., 12 to 14 ft., branches 6 to 7 ft.

Quercus rubra 3½ in. cal., 14 to 16 ft., branched 7 to 9 ft.

Trees with ascending branches (example—*Ulmus americana* and *Tilia tomentosa*) may be branched 1 foot or more below the standard height and still provide proper clearance, which is the purpose of this specification.

1.1.3 HEIGHT RELATIONSHIP TO CALIPER BY TYPES

It is recognized that climatic conditions in different sections of the country produce trees of different caliper-height proportions. Trees from one region of the country may have less caliper in proportion to height while trees from another section may have greater caliper in proportion to height than shown in the following table.

The table in Type 1 shows the average height range and the maximum heights permitted (See 1.1.3.1)

1.1.3.1 Type 1. Shade Trees

The height relationship to caliper, for most standard shade trees, will be as follows:

Caliper	Average Height Range	Maximum Heights
½ in.	5 to 6 ft.	8 ft.
¾ in.	6 to 8 ft.	10 ft.
1 in.	8 to 10 ft.	11 ft.
1¼ in.	8 to 10 ft.	12 ft.
1½ in.	10 to 12 ft.	14 ft.
1¾ in.	10 to 12 ft.	14 ft.
2 in.	12 to 14 ft.	16 ft.
2½ in.	12 to 14 ft.	16 ft.
3 in.	14 to 16 ft.	18 ft.
3½ in.	14 to 16 ft.	18 ft.
4 in.	16 to 18 ft.	22 ft.
5 in.	18 ft. and up	26 ft.

Sizes under one inch may be calipered if desired.

Examples:

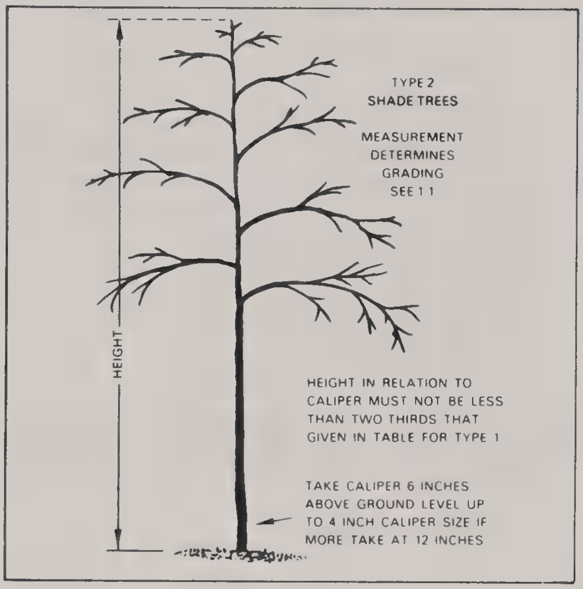
Acer rubrum, A. saccharinum
Betula
Cinnamomum camphora
Fraxinus americana, F. pennsylvanica, F. uhdei
Ginkgo
Gleditsia
Liriodendron
Platanus
Populus
Quercus macrocarpa, Q. palustris, Q. phellos, Q. virginiana
Salix
Tilia americana

1.1.3.2 Type 2. Shade Trees

Trees of slower growth which will not usually attain the height measurement in relation to caliper as in Type 1. The height, however, should not be less than two-thirds the height relationship given for Type 1. (See 1.1.3.1)

Examples:

Aesculus
Celtis
Cladrastis lutea
Fagus sylvatica
Koelreuteria
Laburnum
Liquidambar
Magnolia grandiflora
Nyssa
Olea europaea
Quercus alba
Sorbus
Tilia cordata, T. euchlora



1.1.3.3 Type 3. Small Upright Trees

This is a broad group including small, upright trees which may be grown as single-stem plants, as clumps, or as shrubs.

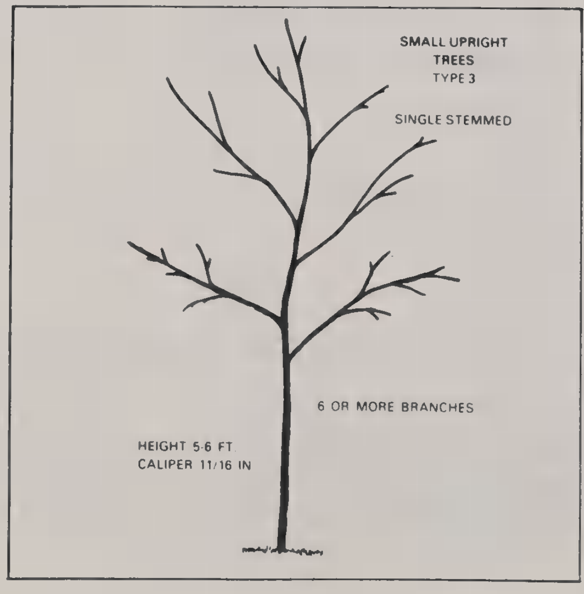
Up to 6 feet, height shall be the governing measurement. Sizing shall be in 1 foot intervals. At 6 feet and over, caliper takes precedence. A height relative to caliper may be specified but shall not be considered in determining minimum diameter ball sizes.

For single-stem plants, the minimum relationship for height caliper and branching will usually be as follows:

2 ft., 5/16" caliper, three or more branches
3 ft., 7/16" caliper, four or more branches
4 ft., 9/16" caliper, five or more branches
5 ft., 11/16" caliper, six or more branches
3/4" caliper, seven or more branches

Examples:

Acer campestre, A. circinatum
Cercis
Crataegus
Halesia
Malus (most crabapples)
Prunus cerasifera 'Thundercloud'
Prunus serrulata, P. subhirtella
Styrax
Syringa reticulata



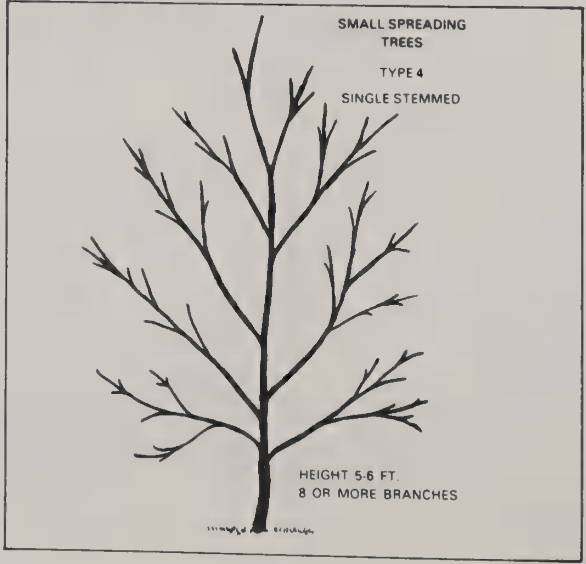
1.1.3.4 Type 4. Small Spreading Trees

This is a broad group including small, spreading trees of dwarf growth habit and certain large shrubs grown in tree or multi-stem form.

Up to 6 feet, height shall be the governing measurement. Sizing shall be in 1 foot intervals. At 6 feet and over, caliper takes precedence. A height relative to caliper may be specified but shall not be considered in determining minimum diameter ball sizes.

For single-stem plants, the minimum branching will be as follows:

2 ft., four or more branches
3 ft., five or more branches
4 ft., seven or more branches
5 ft., eight or more branches
3/4 in. caliper, eight or more branches



Examples

Acer palmatum, A. griseum
Cornus
Lagerstroemia indica
Ligustrum japonicum (tree forms), *L. lucidum*
Magnolia soulangiana, M. stellata
Malus sargentii
Viburnum prunifolium

1.1.4 TREES FOR OTHER USES

Trees for special uses should be branched or pruned naturally according to type. Where a form of growth is desired which is not in accordance with a natural growth habit, this form should be so specified.

Examples:

Cut back or Sheared—trees that have been pruned back so as to multiply the branching structure and to develop a more formal effect.

Topiary—trees sheared or trimmed closely in a formal geometric pattern.

1.1.5 MULTI-STEM TREES

Multi-stem trees occur naturally in many genera, and other kinds may be grown multi-stem in the nursery. Multi-stem trees may be further defined as Clump form and Shrub form.

Clump form: Having two or more main stems arising from the root crown or from the main trunk not more than 6 inches from the ground level. The main stems shall have branching typical for the species or cultivar.

Shrub form: A tree with multiple stems arising from the root crown in the manner of a shrub.

Examples:

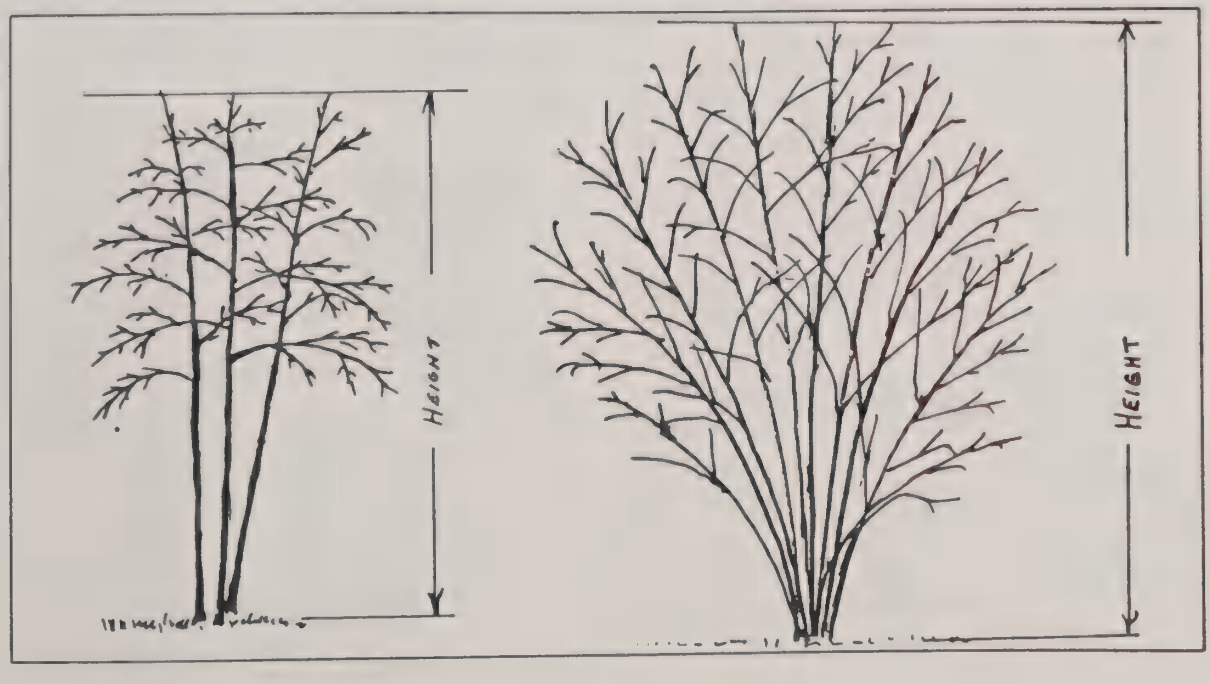
Clump form:
Acer ginnala, A. rubrum
Alnus glutinosa
Amelanchier laevis
Betula nigra
Carpinus caroliniana
Cercis canadensis
Cornus alternifolia, C. florida
Corylus avellana
Crataegus punctata
Fraxinus pennsylvanica var. *lanceolata*
Gleditsia triacanthos inermis
Hamamelis virginiana
Magnolia soulangiana, M. virginiana
Malus floribunda
Prunus padus
Syringa reticulata
Tilia cordata, T. euchlora
Viburnum plicatum, V. prunifolium

Shrub form:
Amelanchier arborea, A. grandiflora
Cornus kousa, C. mas
Corylus americana
Cotoneaster multiflorus
Crataegus cordata, C. crus-galli
Hamamelis vernalis
Lagerstroemia indica
Magnolia stellata
Malus sargentii
Prunus cistena
Syringa vulgaris
Viburnum lantana, V. lentago, V. opulus

1.1.5.1 Measurement of Multi-stem Trees

In size grading multi-stem trees, height shall be the governing measurement. Height shall be defined as the measurement taken from the ground level to the average uppermost point of growth of the plant.

Sizes shall be listed in 1-foot increments to 8 feet and 2-foot increments thereafter. For purposes of simplicity, only one size per "grade" will be listed. That size will be the minimum size allowable for that grade and shall include plants from that size up to, but not including, the next larger size.



Example: *Acer ginnala*, 6'. This would include *Acer ginnala* 6 feet high up to, but not including, 7 feet high from the ground level to the average uppermost point of growth of the plant.

Although height will be the determining factor, for landscape specifications other definitive measurements may be used to further "picture" the desired plant. Such added factors as a number of stems and plant width may be specified.

Multi-Stem Trees with Ascending Growth Habit

Average Height	Minimum Diameter Ball
4 feet	14 inches
5 feet	16 inches
6 feet	18 inches
7 feet	20 inches
8 feet	22 inches
10 feet	24 inches
12 feet	28 inches
14 feet	32 inches
16 feet	38 inches
18 feet	42 inches
20 feet	48 inches

Exception:

Specifications for balling and burlapping multi-stem trees with a spreading growth habit shall provide for balls one size larger than sizes specified above for multi-stem trees with ascending growth habit.

1.1.6 PALMS

In size grading palm trees, height shall take precedence. Either of two heights may be specified: overall height or trunk height.

Overall height is the perpendicular height from the ground to the top of the arc made by the uppermost arching frond with the tree standing in natural position.

Trunk height is measured from the ground line to the base of the heart leaf.

1.1.7 SPECIMEN TREES

This recommendation for specification writers applies to both deciduous and evergreen trees. When "specimen" trees are called for in landscape specifications, the desired specimen characteristics must be stated, including deviations from Standard minimums for caliper, height, fullness of branching, rootball, etc.

1.2 BARE ROOT SPECIFICATIONS

1.2.1 NURSERY GROWN—SPREAD OF ROOTS

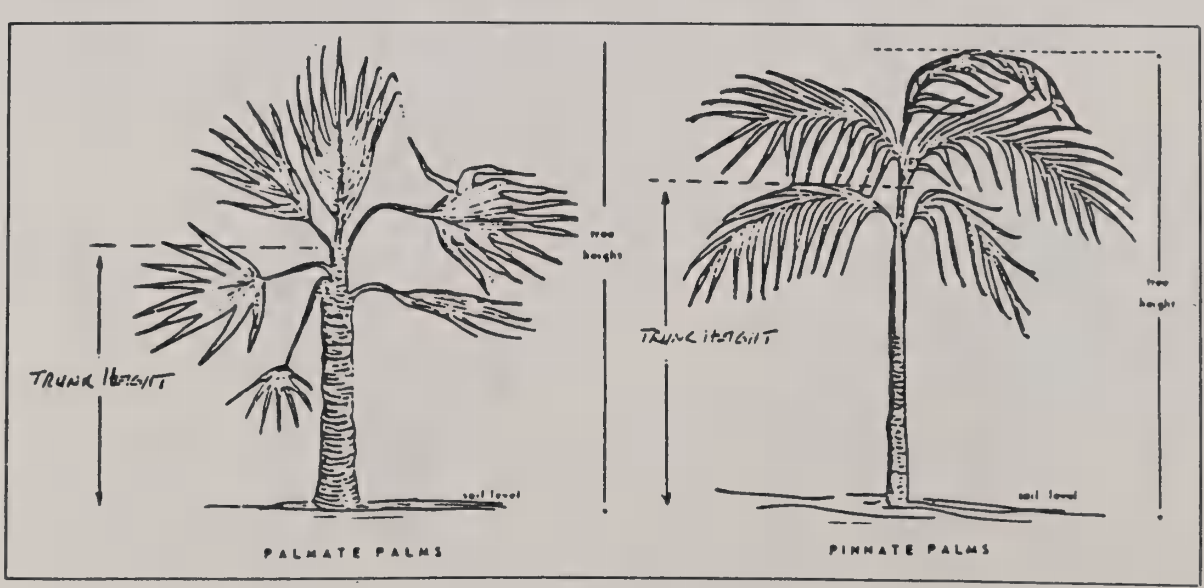
All bare root trees shall have a well branched root system characteristic of the species. The following table represents the approved minimum root spread for nursery grown shade trees.

Caliper	Average Height Range	Minimum Root Spread
½ in.	5 to 6 ft.	12 in.
¾ in.	6 to 8 ft.	16 in.
1 in.	8 to 10 ft.	18 in.
1¼ in.	8 to 10 ft.	20 in.
1½ in.	10 to 12 ft.	22 in.
1¾ in.	10 to 12 ft.	24 in.
2 in.	12 to 14 ft.	28 in.
2½ in.	12 to 14 ft.	32 in.
3 in.	14 to 16 ft.	38 in.

1.2.2 COLLECTED—SPREAD OF ROOTS

Trees collected from native stands or established plantings must be so designated. The spread of roots, bare root collected trees, shall be ⅓ greater than the spread of roots, bare root nursery grown, as tabulated above.

Trees collected from wild or native stands may be considered nursery grown when they have been successfully re-established in the nursery row and grown under regular nursery cultural practices for a minimum of two growing seasons and have attained adequate root and top growth to indicate full recovery from transplanting into the nursery row.



1.3 BALLING AND BURLAPPING SPECIFICATIONS

Ball sizes should always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

It is recognized that balling of nursery grown stock can be accomplished by hand digging or by mechanical devices especially designed for nursery conditions. The use of digging machines is an acceptable nursery practice.

1.3.1 NURSERY GROWN

The following table represents the recommended minimum sizes of balls for trees which are being grown in the nursery under favorable growing conditions and which have received the proper cultural treatment to develop a well branched root system.

These specifications are for plants either hand dug or machine dug with the ball of earth in which they are growing.

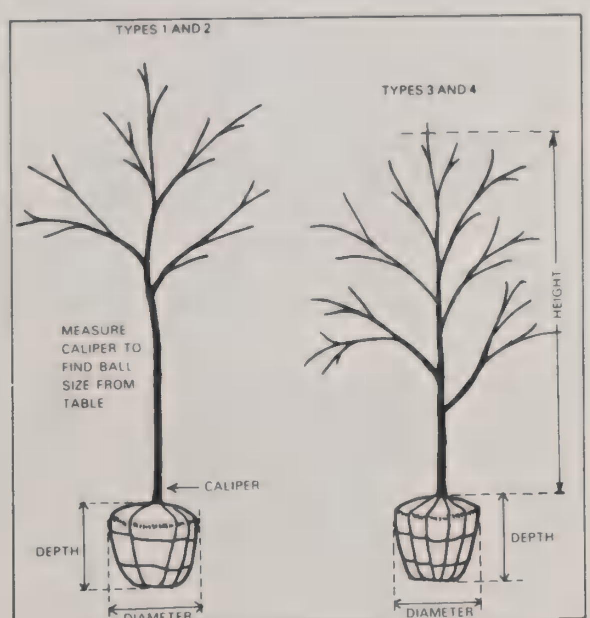
Plants dug to specifications in the foregoing table should have the trunk or stem of the plant in the center of the earth ball. A tolerance of 10% of the diameter is the maximum deviation allowable.

Example: For a tree with a 30-inch rootball, the center of the plant at ground level must be within a circle 13½ inches from the outer edge of the ball.

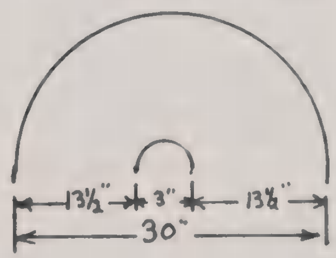
It is recognized that plants having a coarse or widespreading root system because of natural habit of growth, soil condition, infrequent transplanting practice, or plants which are moved out of season, would require a size of ball in excess of the recommended sizes.

1.3.2 COLLECTED

It is generally recognized that plants growing in their native state will sustain a much more severe shock when transplanted than the same kinds of plants when nursery grown. If collected material is moved, considerably larger ball than that recommended for transplanted nursery stock is required, because of the unrestricted root development and the varying conditions of soil in which such material is found.



Shade Trees Types 1 and 2		Trees Types 3 and 4	
Caliper	Minimum Diameter Ball	Up to 6 ft.- Height 6 ft. & over- Caliper	Minimum Diameter Ball
Inches	Inches	Feet/Inches	Inches
½	12	2 ft.	10
¾	14	3 ft.	12
1	16	4 ft.	14
1¼	18	5 ft.	16
1½	20	¾ in.	16
1¾	22	1 in.	18
2	24	1½ in	20
2½	28	1¾ in.	22
3	32	2 in.	24
3½	38	2½ in.	28
4	42	3 in.	32
4½	48	3½ in.	38
5	54	4 in.	42
5½	57	4½ in.	48
6	60	5 in.	54
7	70	5½ in.	57
8	80	6 in.	60
		7 in.	70
		8 in.	80



The minimum ball sizes shall be equal to those specified in 1.3.1 for the next larger size nursery grown stock.

Trees collected from wild or native stands may be considered nursery grown when they have been successfully re-established in the nursery row and grown under regular nursery cultural practices for a minimum of two growing seasons and have attained adequate root and top growth to indicate full recovery from transplanting into the nursery row.

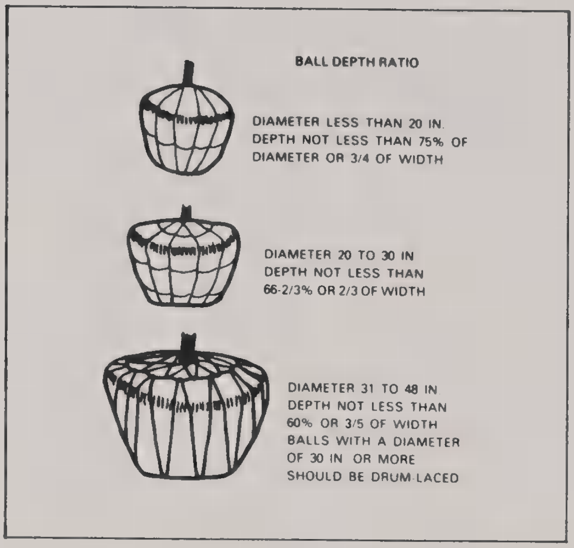
1.3.3 PLANTATION GROWN STOCK

Plants which have been systematically planted in fertile, friable soil which is relatively free of stones and foreign matter, but where plants have had a minimum of after-care.

The minimum ball sizes shall be equal to those specified in 1.3.1 for the next larger size nursery grown stock.

1.3.4 BALL DEPTHS

Under certain soil and regional conditions, plants have root systems of proportionately less depth and greater diameter. These require a more shallow but wider ball to properly encompass the roots. Conversely, in other soils and in certain regions roots develop greater depth and less spread, requiring an exceptionally deep ball which may be smaller in diameter and greater in depth than the size recommended.



For the greater part of the country, ball depths will carry the following ratios:

Balls with diameters less than 20 inches—depth not less than 75% of diameter.

Balls with diameters of 20 inches to 30 inches inclusive—depth not less than 66⅔% of diameter.

Balls with diameters of 30 inches to 48 inches inclusive—depth not less than 60% of diameter.

Balls with diameters over 48 inches will have the depth scaled down proportionately.

1.3.5 BURLAPPING

Burlap or other suitable material shall completely cover the root ball. This wrapping shall be between the earth ball and the lacing or ball supporting device.

1.3.6 BALL SUPPORTING DEVICES

Ball supporting devices, such as wire baskets, shall hold the ball in a firm, rigid condition.

1.4 CONTAINER GROWN SPECIFICATIONS

All container grown trees shall be healthy, vigorous, well rooted and established in the container in which they are sold. They shall have tops of good quality and in a healthy growing condition.

An established container grown tree shall be a tree transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping.

Dwarf and light growing varieties may be 1 or 2 sizes smaller than standard for a given size container.

All shade and flowering trees in a container should be sold by both plant size and container size. The plant size shall agree with sizes specified in Section 1.1.1 of this chapter, and the container sizes shall agree with the plant container class table in the Foreword on page iii.

The following table gives tree sizes and acceptable container sizes:

Tree Height	Container Size
12 in.	#1
18 in.	
2 ft.	
3 ft.	
2 ft.	#2
3 ft.	
4 ft.	
4 ft.	#3
5 ft.	
6 ft.	

1.5 BALLED AND POTTED

Balled and potted plants are field-grown nursery plants, dug with a ball of earth still intact in which they are growing, and which, in lieu of burlapping, are placed in a container to retain the ball unbroken.

Ball sizes shall always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

The minimum ball size specification for "balled and potted" plants shall be the same as for "balled and burlapped" plants. (See 1.3.1)

1.6 PROCESSED BALLED

A processed balled shade or flowering tree is one dug bare root, while dormant, to which a growing medium is added around the roots to form a ball designed to sustain plant growth.

The following table represents the recommended minimum sizes of processed balls for trees processed by machine or hand. All trees shall have a root system which has been developed by proper cultural practices.

Single Stem Trees Types 1, 2 & 3		Small Spreading Trees Type 4	
Caliper	Minimum Diameter Ball	Height; Caliper	Minimum Diameter Ball
Inches	Inches	Feet/Inches	Inches
½	10	2 feet	10
¾	10	3 feet	10
1	12	4 feet	12
1¼	14	5 feet	12
1½	16	¾ inches	12
1¾	18	1 inch	14
2	20	1¼ inches	14
2½	20	1¼ inches	14
3	28	1¾ inches	18

3 CONIFEROUS EVERGREENS

This section applies to plants generally sold to the retail and landscape trade. For liner grades see section 6.

3.1 GENERAL SPECIFICATIONS

For purposes of simplicity, only one size per "grade" will be listed. That size will be the minimum size allowable for that grade, and as shown shall include plants from that size up to but not including the next larger grade size.

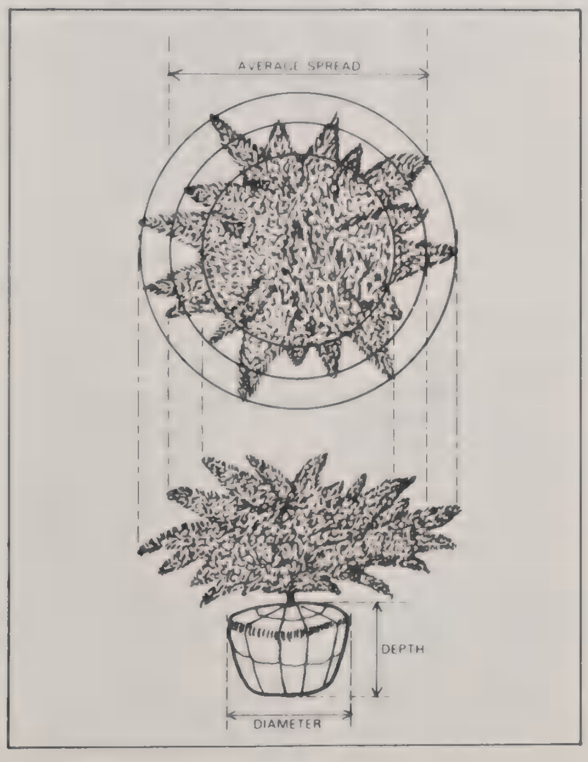
Example: *Taxus media* 'Brownii,' 15 inches. (This could include *Taxus media* 'Brownii' 15 inches in height up to but not including 18 inches and having a minimum spread of 12 inches.)

3.1.1 QUALITY DEFINITIONS

The quality of evergreens offered is assumed to be normal for the species or variety unless otherwise designated as:

Specimen (Spec.) This designation may be used to indicate exceptionally heavy, well shaped plants and is usually applied to the larger commercial sizes and plants which have been cut back or trimmed to form a perfectly symmetrical, tightly knit plant. The letters "X," "XX," or "XXX" may be used to designate the degree of heavy grades in place of using the word "specimen" (spec.).

Collected (Coll.) Natural seedling plants dug from native stands or forest plantings must be so designated. (Also see 3.2.2)



3.1.2 TYPES OF CONIFERS

3.1.2.1 Type 1. Creeping or Prostrate Type

Measurement designates spread (height not considered).
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 4 feet
Use 1 foot intervals from 4 feet up

Measurement should be average of plant and not the greatest diameter. Plants properly trimmed and transplanted should measure the same in any direction. If a plant is uneven, for example, 15 inches the widest way and nine the narrowest, it should be classified as 12″ stock.

Examples:

Juniperus horizontalis cultivars
Juniperus chinensis var. *procumbens*
Pinus mugo var. *mughus*

3.1.2.2 Type 2. Semi-Spreading Type

Measurement designates spread.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 4 feet
Use 1 foot intervals from 4 feet up
Measurement should be average as in Type 1.

Height will be at least one half the spread. Above 3 feet the height will be less than the spread, varying somewhat according to natural growth of the particular species and method of handling.

Spread	Height
6 in. up to 3 ft.	Same as spread
3 ft.	2½ to 3½ ft.
4 ft.	3 to 4 ft.

Examples:

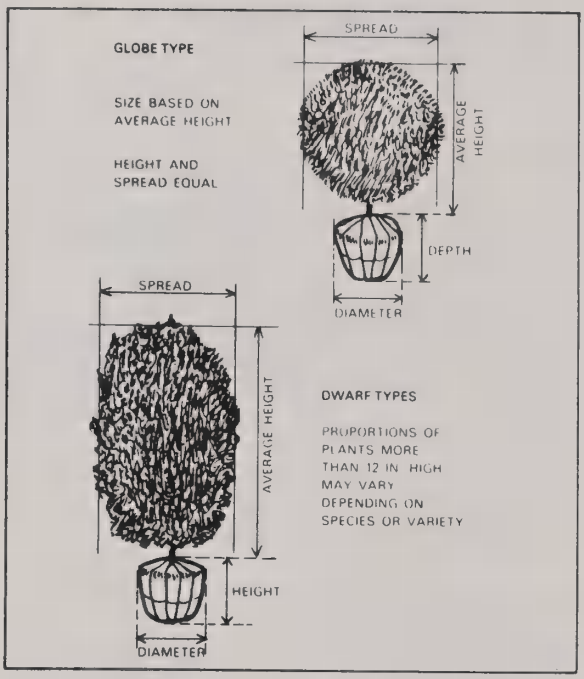
Juniperus chinensis 'Pfitzerana', *J. sabina*
Taxus cuspidata, *T. cuspidata* 'Nana', *T. media* 'Densiformis'

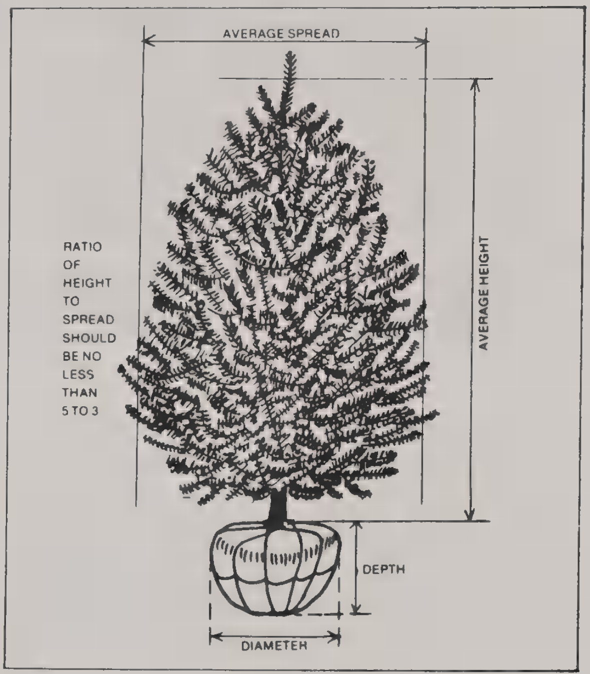
3.1.2.3 Type 3. Broad Spreading, Globe and Upright Types

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 4 feet
Use 1 foot intervals from 4 feet up

Spread will usually be equal to height in well grown material up to twelve inches. From there on there will be a variation of spread to height depending on the variety.

Height	Minimum Spread
6 in.	6 in.
9 in.	9 in.
12 in.	10 in.
15 in.	12 in.
18 in.	15 in.
2 ft.	18 in.
2½ ft.	21 in.
3 ft.	24 in.





Many broad spreading and globe types included in this classification will have the same or greater spread as height, even in the larger sizes.

Examples:

Chamaecyparis obtusa 'Nana'; *C. pisifera* 'Plumosa Nana,' 'Squarrosa Minima'
Juniperus virginiana 'Globora'
Picea abies 'Nidiformis'
Taxus media 'Brownii'
Thuja occidentalis 'Globosa,' 'Little Gem'
Upright growing dwarf types may approach the minimum dimensions above.

Examples:

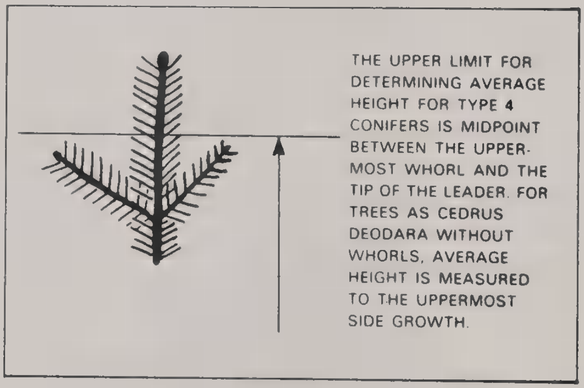
Chamaecyparis obtusa 'Gracilis'
Juniperus squamata 'Meyeri'
Thuja occidentalis 'Hoveyi,' 'Compocta,' 'Woodwardii'; *T. orientalis* 'Goldbush'

3.1.2.4 Type 4. Cone Type (Pyramidal)

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 3 feet
Use 1 foot intervals from 3 feet to 10 feet
Use 2 foot intervals from 10 feet up

The ratio of height to spread of properly grown material should not be less than 5 to 3.

Height	Spread
12 inch	8 to 12 inches
15 inch	9 to 15 inches
18 inch	12 to 18 inches
2 feet	15 to 21 inches
2½ feet	18 to 24 inches
3 feet	21 to 30 inches
4 feet	2½ to 3 feet
5 feet	3 to 4 feet



Examples:

Abies
Cedrus deodara
Chamaecyparis pisifera and varieties (except **dwarf types**)
Picea abies (conical types)
Pinus (except dwarf type)
Pseudotsuga menziesii
Taxus cuspidata 'Capitata'
Thuja occidentalis, T. orientalis (conical types)
Tsuga canadensis, T. caroliniana

3.1.2.5 Type 5. Broad Upright Type

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 3 feet
Use 1 foot intervals from 3 feet to 10 feet
Use 2 foot intervals from 10 feet up

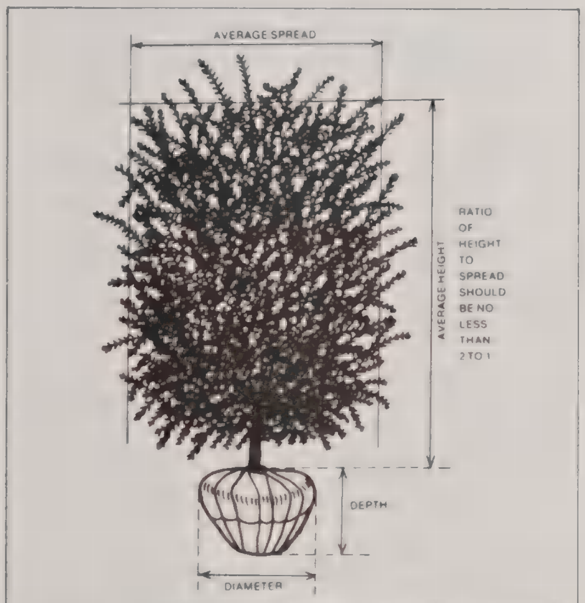
This group includes all the broader, upright growing evergreens which develop a straight sided form with many upright branches or "leaders."

The ratio of height to spread of properly grown material should not be less than 3 to 1.

Height	Spread
12 inches	8 to 12 inches
15 inches	9 to 15 inches
18 inches	12 to 18 inches
2 feet	15 to 21 inches
2½ feet	18 to 24 inches
3 feet	21 to 30 inches
4 feet	2½ to 3 feet
5 feet	3 to 4 feet

Examples:

Chamaecyparis lawsoniana 'Alumii'
Juniperus chinensis 'Keteleeri,' *J. scopulorum*
Taxus media 'Hicksii,' 'Hatfieldii'



3.1.2.6 Type 6. Columnar Type

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 3 feet
Use 1 foot intervals from 3 feet to 10 feet
Use 2 foot intervals from 10 feet up

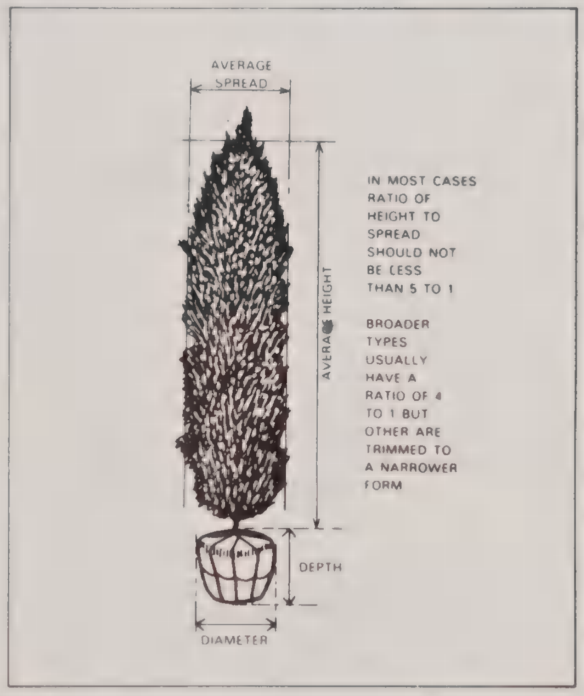
This group includes all the upright growing evergreens which naturally develop a straight sided form or one that tapers only slightly from the ground to a point more than half the height.

The broader types will usually have a ratio of height to spread of 4 to 1. Many forms, however, will not attain this ratio, and even those of broad habit may be trimmed to advantage into a narrowed form. However, in most cases the ratio of height to spread should be less than 5 to 1.

Height	Spread
12 inches	3 to 6 inches
15 inches	4 to 7 inches
18 inches	5 to 8 inches
2 feet	6 to 9 inches
2½ feet	7 to 10 inches
3 feet	9 to 12 inches
4 feet	12 to 15 inches
5 feet	15 to 18 inches
6 feet	18 to 21 inches
7 feet	21 to 24 inches
8 feet	24 to 30 inches

Examples:

Cupressus sempervirens
Juniperus communis, J. virginiana (columnar type varieties)
Taxus baccata 'Fastigiata'
Thuja occidentalis, T. orientalis (columnar type varieties)



3.2 BALLING AND BURLAPPING SPECIFICATIONS

Ball sizes should always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

It is recognized that balling of nursery grown stock can be accomplished by hand digging or by mechanical devices especially designed for nursery conditions. The use of digging machines is an acceptable nursery practice.

3.2.1 NURSERY GROWN

The following table represents the recommended minimum sizes of balls for conifers which are being grown in the nursery under favorable growing conditions and which have received the proper cultural treatment to develop a well branched root system.

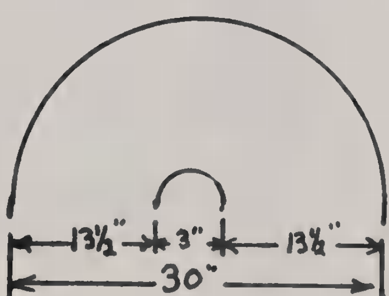
Where it has been a cultural practice to shear, prune, disbud or otherwise impede the natural growth rate of this group of plants, other than by root pruning, trunk diameter shall be used to determine the minimum ball size of trees.

Measurement of trunk diameter shall be made within 6 inches above ground level.

Minimum ball diameters shall be those established under Section 1.3.1 "Shade Trees," types 1 and 2. Ball depth shall also be established as in Section 1.3.4 (Ball Depths).

These specifications are for plants either hand dug or machine dug with the ball of earth in which they are growing.

Spreading, Semi-Spreading and Globe or Dwarf Conifers (Types 1, 2 & 3)		Conical and Broad Upright Conifers (Types 4 & 5)	
Spread	**Minimum Diameter Ball**	**Height**	**Minimum Diameter Ball**
18 in.	10 in.	18 in.	10 in.
2 ft.	12 in.	2 ft.	12 in.
2½ ft.	14 in.	3 ft.	14 in.
3½ ft.	18 in.	5 ft.	20 in.
4 ft.	21 in.	6 ft.	22 in.
5 ft.	24 in.	7 ft.	24 in.
6 ft.	28 in.	8 ft.	27 in.
7 ft.	32 in.	9 ft.	30 in.
8 ft.	36 in.	10 ft.	34 in.
		12 ft.	38 in.
		14 ft.	42 in.
		16 ft.	46 in.
		18 ft.	50 in.



*Rapid growing kinds as: *Thuja orientalis* (Oriental Arborvitae), *Juniperus communis* 'Hibernica' (Irish Juniper).

Plants dug to the specifications in the foregoing table should have the trunk or stem of the plant in the center of the earth ball. A tolerence of 10% of the diamters is the maximum deviation allowable.

Example: For a tree with a 30-inch rootball the, center of the plant at ground level must be within a circle 13½ inches from the outer edge of the ball.

It is recognized that plants having a coarse or widespreading root system because of natural habit of growth, soil condition, infrequent transplanting practice, or plants which are moved out of season, would' require a size of ball in excess of the recommended sizes. It is also recognized that special handling

Columnar Conifers (Type 6)			
Regular growing kinds		**Rapid growing kinds***	
Height	**Minimum Diameter Ball**	**Height**	**Minimum Diameter Ball**
18 in.	10 in.	18 in.	8 in.
2 ft.	12 in.	2 ft.	9 in.
3 ft.	13 in.	3 ft.	11 in.
4 ft.	14 in.	4 ft.	12 in.
5 ft.	16 in.	5 ft.	14 in.
6 ft.	18 in.		
7 ft.	20 in.		
8 ft.	22 in.		
9 ft.	24 in.		
10 ft.	27 in.		
12 ft.	30 in.		
14 ft.	33 in.		
16 ft.	36 in.		
18 ft.	40 in.		

of certain material, constitute cases where the sizes recommended may be excessive, for example, such as stock grown in pots or other containers, field plants recently planted out from containers or with smaller balls, or plants which has been frequently transplanted or root pruned.

3.2.2 COLLECTED

The minimum sizes of ball shall be equal to that specified in 3.2.1 for the next larger size nursery grown stock.

Plants collected from wild or native stands may be considered nursery grown when they have been successfully re-established in the nursery row and grown under regular nursery cultural practices for a minimum of two growing seasons and have attained adequate root and top growth to indicate full recovery from transplanting into the nursery row.

3.2.3 PLANTATION GROWN STOCK

Plants which have been systematically planted in fertile, friable soil which is relatively free of stones and foreign matter, but where plants have had a minimum of after-care.

The minimum ball sizes shall be equal to that specified in 3.2.1 for the next larger size nursery grown stock.

3.2.4 BALL DEPTHS

For the greater part of the country, ball depths will carry the following ratios:

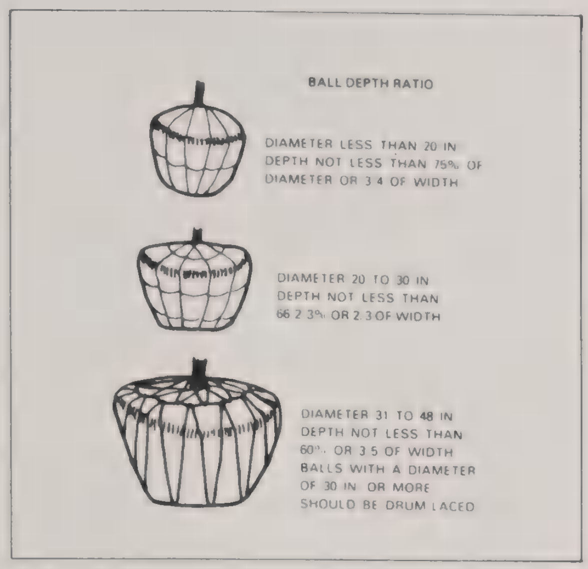
Balls with diameters less than 20 inches—depth not less than 75% of diameter.

Balls with diameters of 20 inches to 30 inches inclusive—depth not less than 66⅔% of diameter.

Balls with diameters of 30 inches to 48 inches inclusive—depth not less than 60% of diameter.

Balls with diameters over 48 inches will have the depth scaled down proportionately.

Under certain soil and regional conditions, plants have root systems of proportionately less depth and greater diameter. These require a more shallow but wider ball to properly encompass the roots. Conversely, in other soils and in certain regions roots develop greater depth and less spread, requiring an exceptionally deep ball which may be smaller in diameter and greater in depth than the size recommended.



3.2.5 BURLAPPING

Burlap or other suitable material shall completely cover the root ball. This wrapping shall be between the earth ball and the lacing or ball supporting device.

3.2.6 BALL SUPPORTING DEVICES

Ball supporting devices, such as wire baskets, shall hold the ball in a firm, rigid condition.

3.3 CONTAINER GROWN SPECIFICATIONS

All container grown conifers shall be healthy, vigorous, well rooted and established in the container in which they are sold. They shall have tops of good quality and in a healthy growing condition.

An established container grown conifer shall be a conifer transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping.

Dwarf and light growing varieties may be 1 or 2 sizes smaller than standard for a given size container.

All coniferous evergreen plants sold in a container should be sold by both plant size and container size. The plant size shall agree with sizes specified in Section 3.1.2 of this chapter, and the container sizes shall agree with the plant container class table in the Foreword on page iii.

3.3.1 TYPES 1, 2 AND 3

Spread (Type 1, Spreading Conifers and Type 2, Semi-Spreading Conifers)

Height (Type 3, Globe or Dwarf Conifers)

	Container Size
6 in.	#1
9 in.	
12 in.	
12 in.	#2
15 in.	
18 in.	#3
2 ft.	
2½ ft.	

3.3.2 TYPES 4, 5 AND 6*

(Conicals, Broad Upright, and Columnar Conifers)

Height	Container Size
6 in.	#1
9 in.	
12 in.	
15 in.	
18 in.	
12 in.	#2
15 in.	
18 in.	
2 ft.	
18 in.	#3
2 ft.	
2½ ft.	
3 ft.	
3½ ft.	

*Except for extreme columnar types as *Cupressus sempervirens* (Italian cypress), which is acceptable 1 or 2 sizes taller than standard for a given container.

3.4 BALLED AND POTTED

Balled and potted plants are field-grown nursery plants, dug with a ball of earth still intact in which they are growing, and which, in lieu of burlapping, are placed in a container to retain the ball unbroken.

Ball sizes shall always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

The minimum ball size specification for "balled and potted" plants shall be the same as for "balled and burlapped" plants. (See 3.2.1)

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